Choosing a dangerous limit for climate change: An investigation into how the decision making process is constructed in public discourses.

by

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Declaration

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

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SUMMARY

International climate change policy is predicated on the claim that climate change is a phenomenon with a single, global dangerous limit of two degrees of warming above the pre-industrial average. However, climate science does not provide sufficient empirical evidence to determine such an exact limit. In addition, a single limit incorrectly assumes that social and physical vulnerabilities to climate change are uniformly distributed in space and time. Public commentaries play an important role in shaping public engagement with an abstract concept such as climate change. This research project examines how public discourses construct the dangerous limits to climate change decision making process. My analysis draws on elite theory to argue that the two degree limit is a discourse which constructs climate change as a problem solvable within existing value systems and patterns of social activity. A comparison of primary and secondary data drawn from diverse sources is used to chart the key historical, social and cultural elements present in the construction and reproduction of the two degree dangerous limit discourse. The historical dimension of my analysis shows that public commentaries have 'black boxed' the genesis of the two degree dangerous limit idea. I demonstrate how claims of a consensus amongst elite policy and science actors are central to developing a dangerous limit ideology amongst influential public audiences. The two degree discourse elevates the idea of a single dangerous limit to the status of fact, and in so doing marginalises egalitarian and ecological perspectives. I conclude that the two degree limit is a construct which makes possible an international environmental regime safe for the interests of elite actors.

Chapter 1

Introduction

1.1 Aims of this research

This research answers the following question:

How is the idea of a two degree dangerous limit to anthropogenic forcing of the climate constructed in public discourses?

It is well established that human activity is changing the chemical composition of the Earth's atmosphere. Increased atmospheric concentrations of greenhouse gases, in particular carbon dioxide (CO_2), are contributing to increases in the Earth's near surface temperature. The Earth's near surface temperature has already risen by a global average of 0.7 degrees centigrade (^oC) since 1860 (Smith, Schneider, Oppenheimer, Yohe, Hare, Mastrandrea, Patwardhan, Burton, Corfee-Morlot, Magadza, Füssel, Pittock, Rahman, Suarez and van Ypersele, 2009: 921), largely as a result of CO_2 emissions generated by industrial activity. Current atmospheric concentrations of CO_2 stand at 390 parts per million (ppm), compared to the pre-industrial average of 280ppm, a 40% increase over the pre-industrial norm (UK Department of Energy and Climate Change, 2011: 5). Whilst there is some disagreement about historical atmospheric concentrations of CO_2, the most conservative interpretation of the data suggests this is the highest level for 500,000 years (van der Sluijs and Turkenburg, 2006: 247), though it has been claimed that the level is the highest for at least 20,000,000 years (Houghton, Ding, Griggs, Noguer, van der Linden, Dai, Maskell, Johnson, 2001: 7).

International climate change policy does not seek to return atmospheric concentrations of CO_2 to a pre-industrial norm. Nor is it the aim of international climate change policy to prevent any further warming of the Earth's near surface temperature. Instead the goal enshrined in the Copenhagen Accord is to allow the Earth's near surface temperature to continue warming to a global average of two degrees above the pre-industrial average. Two degrees of warming above the pre-industrial average is described by the EU and signatories to the Copenhagen Communiqué as a dangerous limit (EU 1996; UNFCCC, 2009). The dangers that it is feared will be realised beyond two degrees of warming are not trivial. Even an increase of just 1.5^oC to 2 ^oC of warming has been projected to lead to the extinction of 10-15% of all plant and animal species, to the risk of highly adverse and severe impacts on food production in some African countries, increasing burden from malnutrition, increased mortality from heat waves, floods,

and droughts and many hundreds of millions at risk of increased water stress in Africa, Asia, and Latin America (Hare, 2009: 20).[1]

The construction of climate change as a phenomenon with a single global dangerous limit masks some significant variations in how this change will be experienced. Firstly, it is a global average which is derived from widely divergent warming levels in different parts of the globe. A 2°C increase in the global-average surface temperature above its 1750 value is likely, for example, to result in up to 4°C warming in the middle of large continents and even larger increases in the polar regions. Regional changes will be even more extreme if global average temperatures rise by 3°C or higher (Bierbaum, Holdren, MacCracken, Moss, and Raven, 2007: 2). (See Appendix 1, Climate change index).

Secondly, the resilience of environmental and social systems to climate impacts is not evenly distributed; two degrees of warming is more deleterious for some systems than others (Smith, et al., 2009). (See Appendix 2, Reasons for concern). In addition, what is deemed worthy of protecting from the impacts of climate change is largely culturally determined, and hence what counts as dangerous climate change is multivalent (Hulme, 2009).

Alongside the questions about the ontological veracity of a single global dangerous limit, doubts have been raised about the wisdom of trying to develop effective mitigations strategies through international agreements (Prins, Galiana, Christopher, Grundmann, Korhola, Laird, Nordhaus, Pielke Jnr, Rayner, Sarewitz, Shellenberger, Nico and Hiroyuki, 2010). These concerns are at source a reflection of the failure of existing climate change agreements, such as Kyoto, to deliver any meaningful reductions in emissions of greenhouse gases (Prins and Rayner, 2007). Such has been the extent of this failure, that planning has now begun for adapting to a world of four or more degrees of warming (Anderson and Bows, 2008; Adger, Dessai, Goulden, Hulme, Lorenzoni, Nelson, Naess, Wolf, and Wrefor. 2009; Mabey, Gulledge, Finel and Silverthorn, 2011; New, Liverman, Betts, Anderson and West, 2011).

The credibility of the single global dangerous limit construct is brought further into question by the uncertainties which characterise projections of future climate change scenarios. Whilst this thesis recognises that uncertainty is to a great extent in the eye of the beholder, the complexity of the interactions between a global atmospheric/oceanic circulation system and global social systems are difficult to model (Moss, Pahl-Wostl and Downing, 2000; Dessai Hulme, Lempert and Pielke, Jr., 2010). Planners and decision makers also need extremely

[1] These projections are probabilistic assessments, which include subjective judgements about the values to use for various parameters. On the positive side, allowing for this subjectivity means the effects may not be this extreme. Neither do the projections take account of adaptive strategies that may be employed to alleviate some of these impacts. Conversely the impacts may be much more severe than indicated by these projections, and it may not be possible to implement successful adaptive strategies.

granular information, and that granularity is beyond the scope of current modelling capability (Dessai et al., 2010). Knowing that climate change will increase the intensity of rainfall in the UK does not make it possible to know when, where and to what extent extreme flooding will occur. Yet, against the backdrop of these profound uncertainties and variability in vulnerability to climate impacts, a clear and sharply defined dangerous limit has been identified. How and why? These are extremely important issues, given the gravity of the changes anticipated to result from anthropogenic forcing of the climate. Climate change is, to varying degrees, expected to impact on all of humanity, and to bring about, in human timescales, permanent changes to the biosphere. Plans to stabilise atmospheric concentrations of greenhouse gases at a level that warms the world by up to two degrees constitutes a permanent change in the global environment, one that will mean humans henceforth inhabit the world at the very edge of climatic danger, as defined by elite policy actors.

Current mitigation strategies imply significant, widespread, long lasting and largely negative impacts for the majority, if not all, of humanity. My research is therefore motivated by an interest in defining the extent of public involvement in the decision making process about how much warming should be allowed. The first, overarching research question posed at the beginning of this introduction provides the broad framework through which I approach this work.

The main research question is approached through three subsidiary research questions:

- In what texts are public discourses on the two degree limit to be found, and how do these discourses vary in their treatment of the concept?
- How do public discourses on the two degree dangerous limit differ from those expressed in expert discourses?
- What entities, events and actors are invoked in public and expert discourses on the two degree dangerous limit? Are they used to justify or critique the two degree dangerous limit?

Expert discourses on the two degree dangerous limit are gleaned from academic literature, policy documents, expert conferences and interviews with key actors in the climate change debate. The public discourses examined include newspaper reports and online news services, film, television documentaries, radio programmes, popular science books, environmental campaign literature and reports from policy/science institutions.

This thesis uses the term 'commentary' in a descriptive sense, to refer simply to passages or sentences from a range of different sources, both written and verbal. These sources are defined as texts for the purposes of this research project. These passages and texts are collectively analysed as discourses. Discourse here means 'the social activity of making meanings with language' (Wodak, 2008: 6). It is on a collective basis that these passages and texts are categorised as discourses because the passages and texts I analyse, in making meaning, 'overlap, influence and compete with one another; they appeal to one another's "truths" for authority and legitimation' (Scott, 1988: 759). Climate change is an abstract concept, a statistical aggregation. Language is therefore central to the construction of a shared public concept of the phenomenon. Discourses build this shared reality. My research seeks to identify the dominant two degree public discourses, and what meanings they give to climate change.

1.2 Contributions of this research

There is a large body of literature, both academic and public, on the issue of climate sensitivity, and what atmospheric concentrations of CO_2 accord with two degrees of warming. There is a smaller, but still significant volume of research on defining dangerous climate change. There is but a handful of commentaries on the two degree limit, and none of these are sociological. My research is the first attempt to describe how the two degree limit is constructed in public discourses and to these discourses with expert analyses of the subject.

Climate change is approached in this work as a social problem, not a scientific problem. My research is sociological because it is not an attempt to address the scientific basis for mapping impacts on to levels of warming. Instead I ask whose interests are served by constructing climate change as a phenomenon with a single global dangerous limit, what is the basis for defining two degrees as a dangerous limit, and how is this decision justified to the public? The analysis of this subject is grounded in elite theory, and so assumes that the defining of climate change as a phenomenon with a two degree dangerous limit is an act of power designed to reproduce existing social relations. A simplistic definition of elite theory assumes those in political and corporate power comprise a single elite capable of being researched as a social entity with shared beliefs and interests (Edgley, 2009: 24). My use of elite theory does not deny that within elite circles there may be some tensions and differences of opinion. Nor am I particularly concerned with identifying who exactly the elite actors are, or how these individuals go about reaching positions of power and influence, a task which has met with limited success in the past (Pareto, 1997). Rather, I am looking at the institutionalisation of

elite interests in the state, with particular attention to the core functions of the state. This core has been described as a zone which is concerned with domestic order, survival, revenue, reproduction of the existing economic order and legitimation (Dryzek, Hunold, Schlosberg, Downes and Hernes, 2002: 663). This core zone features only limited democratic control (ibid). I argue that constructing climate change as a phenomenon with a yet to be reached single dangerous limit serves the functions of the state's core. Outside of these core functions, and excluding the time people spend in the work place, democratic states can be said to operate on a broadly pluralist footing.

I use a comparison between expert analyses and public texts to reveal the differences that exist between these commentaries, and what construction of the two degree limit is favoured by these differences. Do public commentaries on the two degree limit reflect the problems with the concept outlined at the beginning of this introduction? Do they exaggerate those problems? Or do they ignore them altogether?

There are several reasons why it is important to undertake this work. My investigation into public representations of the two degree dangerous limit recognises that constructing climate change as a phenomenon with a single, quantifiable dangerous limit is grounded in 'external' definitions of risk. External definitions of risk are generally driven by elite actors and expert bodies, working within a positivist frame of reference. The definitions used by these actors are external in so much as they draw to some extent on empirical observations of the external world to define the level of risk. The public understand risk less in terms of the objective properties of physical systems, and instead rely on 'internal' definitions that draw on a range of social, cultural and cognitive factors which are more personal and explicitly subjective than the resources used by experts. The external definition of climate change as a problem with a single, objective and scientifically derived dangerous limit is in conflict with these subjective notions of acceptable risk. Pluralist perspectives on climate change policy argue that policy makers are constrained in enacting climate change mitigation strategies where there is little public support for such policies (for example Carter and Ockwell, 2007). Understanding the extent to which there is a disconnect between how the two degree issue is framed in public discourses and the internal definitions of risk the public use to make decisions about risk is an essential step in understanding whether the two degree limit encourages or hinders public acceptance of climate mitigation policies.

Challenges to the veracity of defining climate change as a phenomenon with a two degree dangerous limit are growing even as the target is being enshrined into climate change policy. The two biggest challenges are growing scientific evidence that the impacts defined as dangerous may occur below two degrees of warming (Smith et al., 2009), and secondly, that it

appears increasingly unlikely that the two degree target will be met. If it becomes apparent that it will not be possible to avoid more than two degrees of warming, then it becomes important to understand what responses might replace the two degree target regime, and how these new responses can avoid the failings of previous framings of the climate change phenomenon. To replace one externally defined concept of climate danger with another will likely further alienate the public audience from the climate change discourse. This research will help identify what alternative frames could be used to replace the existing two degree definition of climate change scenarios to be avoided. There is also the possibility that the unflinching commitment to the two degree target expressed in public discourse will make any change in the position on dangerous limits, or the role of targets in climate policy more generally, difficult to justify. The result could be a further erosion in public confidence in the institutions and processes involved in formulating climate change policy.

1.3 Climate change and the limits of modernity

To critique the two degree target may seem to risk rejecting the good in favour of the perfect. It appears as though it will be very difficult, if not impossible, to limit warming to two degrees. It is the best we can do. I do not attempt in this research to articulate an alternative target to the two degree limit. The aim is simply to provide answers to as yet unasked questions, to show how important decisions which implicate us all and have potentially grave consequences are presented in public discourses. However, it is important to briefly provide a response to this perfectly reasonable challenge. The two degree target represents a failed strategy; it does not describe an actually existing division between safety and danger. It has not galvanised policy responses or public engagement; it appears it will not be possible to avoid more than two degrees of warming, and there is still ambivalence amongst the public about any response to climate change which has negative economic implications, and an even greater resistance to the changes needed for an 80% reduction by 2050, a target which itself is not sufficient to prevent dangerous interference with the climate (Harvey, 2007a). It is important to understand how such a failed strategy came to be constructed as a progressive and aspirational goal and by whom. The value of this study lies in its contribution to efforts to ensure the same mistakes are not made by the same institutions operating under the same values when developing a strategy to replace the failure of the two degree regime. Reframing the debate as one about acceptable levels of risk from harm better captures the value laden nature of defining what is it worth risking in order to reproduce existing patterns of social activity. It also demonstrates the impossibility of defining how much is too much climate

change at a global scale. We thus confront the question - does climate change represent the terminus of modernity?

I understand the proposing of a two degree limit to be an act of power which is deeply rooted in the project of modernity; the construction of climate change as a phenomenon manageable through quantification in essence assumes climate change is a problem solvable by modernity, rather than a problem of modernity. Shepherd traces the origins of belief in the possibility of control to the advent of domestication and agriculture (1996: xiv). The idea of uncertainty arose alongside these early attempts at mastery of the world–will the crop come up, will the rains come, will our enemies burn our fields? (ibid). Others, writing in the green anarchist tradition, echo this connection between agriculture and the desire for increased control, both of the natural world and the people in it (Zerzan, 1994, 2002; Diamond, 2005; Jensen, 2006; Brody, 2001). However within the social sciences it is more common to trace the idea of nature as an unruly force in need of control to the genesis of a capitalist class in Europe and the ensuing social, political, scientific and philosophical transformations of first the renaissance, and then the enlightenment (Merchant, 1980; Seymour, 1986; Cooke, 1991). From this latter standpoint the new capitalist class was the seedbed for a quantitative world view which rapidly displaced medieval church teachings (Ellul, 1965; Mumford, 1967; Nef, 1955; Polanyi, 1946). Yack claims that this quantification of the world is the framework within which what is most distinctive about the modern world unfolds (1997: 121), is indeed a bedrock of modernity (Wallerstein, 1996: 8). Rather than unpredictable and revolutionary responses to endless religious wars, starvation and oppression, the new sciences which arose on the back of these quantitative epistemologies offered the promise of piecemeal social improvement through the careful collection and analysis of the appropriate data (Killingsworth and Palmer, 1996: 232). Since then science has increasingly been offered up as a substitute for politics; scientific progress, in offering a speedier, trustier way to improve people's lives offers the promise of escape from fragile and contestable human judgement (Stipple and Paterson, 2007; Ellul, 1965). This thesis investigates the extent to which public discourses are attempting, through the reproduction of the two degree dangerous limit idea, to substitute politics with science.

1.4 What is not discussed in this thesis

The speed at which the climate changes is an important determinant of how hazardous those changes will be. There remains continued uncertainty as to whether changes in the climate will be linear and incremental or occur in a series of rapid large scale changes, sometimes referred

to as “tipping points” or “thresholds”. The idea of rapid non-linear change is relevant to analysis of two degree discourses; indeed the two degree limit is often justified on the basis that it represents a threshold between two distinctly different climate regimes. Efforts by the United Nations Framework Convention on Climate Change (UNFCCC) to provide a set of parameters for defining dangerous climate change includes rates of change as a key parameter for avoiding dangerous impacts, alongside an upper limit for total warming:

> Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.
>
> Article 2, UNFCCC, 1992

The German Advisory Council on Global Change equates this time frame to a rate of warming of no more than 0.2 degrees Celsius per decade (2007: 13-14). Of course, the speed at which the planet warms must be considered a vital determinant of how damaging the changes will be. There is a big difference between the world warming by an average of 2^{o}C overnight, and that same warming occurring over a 50 or 100 year period. Whilst debates about linear versus tipping point change have received a lot of attention in the literature (for example Lowe and Lorenzoni, 2007; Dessai, Adger, Hulme, Turnpenny, Kohler, and Warren, 2004; Lorenzoni, Lowe and Pidgeon, 2005; Lorenzoni, Pidgeon and O’Connor, 2005; Risbey, 2006) actual commentary on what rates of change should be considered dangerous are much less prevalent. That is not a lacuna this research seeks to address, though it is no doubt a subject that could be investigated through similar methodologies to those employed in this thesis.

I do not include analysis of climate sceptic perspectives on the two degree dangerous limit. This is because I am much more interested in how the two degree limit is constructed within broadly progressive or leftist liberal discourses. I argue that for these communities, broadly defined, the idea of a two degree dangerous limit is not largely understood to be ideological, but is instead assumed to be grounded in a rational enlightenment which ostensibly rejects attempts to use science as a political tool. These discourses act as gatekeepers for the limits of reasonable debate for well educated and influential actors. I therefore argue that these groups, institutions and individuals are integral to the acceptance of the two degree dangerous limit as a rational, scientific target for climate change policy.

1.5 Structure of the thesis

My thesis begins with a timeline chapter, tracing the history of the idea that there is a two degree dangerous limit to climate change. The goal of this timeline is to map changes in how, and by whom, two degrees of warming is positioned as a dangerous limit. I map these developments onto Bronstein's model of how elites take ownership of environmental problems (1984). This longitudinal analysis is also used to explore the extent to which the two degree storyline follows the trajectory described by Latour and Woolgar in their exploration of how particular views of the world become black boxed into scientific fact (1979).

The literature review chapter details the knowledge base on to which the two degree limit has been placed. I say placed on to, as opposed to the idea that the two degree limit has grown out of the knowledge we have of climate change. The literature review discusses how the standard tools used in risk analysis have been applied to defining what counts as too much climate change, how uncertainty should be accounted for in climate change scenario modelling and what role physical and social sciences have had in defining what should count as dangerous climate change.

The theoretical review positions my research within the framework of critical sociological analysis. The two approaches I use to ground my research are constructivist accounts of social reality and elite theory. Constructivist theories are used to support my claim that the two degree dangerous limit is a construction designed to legitimate the industrial processes and ideologies of modernity. Elite theory is a broad canon, and so I break it down into the elements of elite theory pertinent to the social actors and institutions most significant to discussion of dangerous limits, and the communities researched in my study. My focus on public representations of the two degree limit means discussion of media theories is an important component of this chapter, alongside consideration of institutional theories.

In the methodology chapter I identify the sources used and why these sources were chosen. I explore how previous research has sought to examine discussion of climate change in public and expert discourses. This existing research tends to exploit broad data sets to capture the wide range of settings, and extended timelines, over which environmental policy is built. My study employs the same approach, and uses both quantitative and qualitative data. It is necessary to cast one's methodological net so wide because the construction of a fixed meaning for a phenomenon as complex and important as climate change involves a variety of actors, across a variety of sites, over an extended timeline. The goal of such research is not so much the defining of a single truth, but rather is intended to explain as much of the process as possible, to increase understanding. Given my interest in comparing expert with public

descriptions of the reasons for a two degree limit, I explain the methodology used to triangulate between the two sets of data. This requires an explanation of the separation of the two sets of commentary and the means by which comparison is carried out. The discursive data is examined through the techniques of discourse analysis. Though there is no one distinct approach to discourse analysis, it is generally used in critical sociology studies to reveal how language operates as an act of power. Given the elite theory frames guiding my research, it is the most appropriate tool to use for understanding how language is used to legitimate the idea of a two degree dangerous limit to climate change.

I use Atlas ti software to manage and analyse my data. The analysis of the data is broken down into three chapters. The first chapter examines which actors and events are invoked when discussing the two degree limit. Here I wish to understand what reason, what motivation, commentators have for discussing the two degree dangerous limit (an issue most pertinent to public commentaries; the interviewees are discussing the issue because they agreed to be interviewed. However, it is still necessary to identify the events and actors referenced in the interviewees' discussion of the two degree limit). The second chapter examines how issues of uncertainty are addressed in commentaries citing two degrees of warming as a two degree limit. To what extent do private and public discourses construct the two degree limit as an accurate and truthful description of the future? Is two degrees of warming represented as a line, below which the world is safe from climatic harm, and above which impacts become dangerous? Does my data show criticism of the idea that, in an area of knowledge so beset by uncertainty, it is possible to identify a single dangerous limit for the world? The third chapter builds on these questions by asking what ideas are utilised to justify or explain the two degree limit. Is it a limit built on an idea of economic necessity, an expression of the precautionary principle, or a scientifically derived limit?

In the discussion chapter that follows the analysis, I draw together the themes that occurred in the three data chapters. I build across both the discourse community and thematic divides employed in the structure of my data analysis to present a coherent unified narrative. I use this chapter to explain the patterns identified in light of the questions posed by my thesis. In addition I synthesise the disparate elements of the commentaries into a single discourse, in effect asking what is the work that this discourse does? Does the idea of a dangerous limit as constructed in this discourse open up or constrain the debate? Does it include or exclude the public from consideration of how much damage can be borne, and to what ends?

Chapter 2

The Two Degree Timeline

2.1 Introduction

Books, films and television documentaries charting the history of the climate change issue[2] generally attempt to synthesise historical accounts of scientific developments alongside the evolution of a political ecology that has arisen in response to the science. Whilst these public narratives tend to adopt a broad perspective on the climate change story, there have also been a few academic papers which have sought to address the history of dangerous climate change specifically (Oppenheimer, 2005; Oppenheimer and Petsonk, 2005; Tol, 2007). Tol's analysis featured discussion of the two degree limit with reference to the relationship between reports from the German Advisory Council on Global Change (WBGU) and EU policy. More recently Hare (2009) and Jaeger and Jaeger (2010) have provided a history of the two degree limit. These reports identify the same markers in the debate as used in my research, with Jaeger and Jaeger providing the more extensive of the two histories. Neither are sociological accounts. This timeline chapter is unique because it places the historical analysis into a broader sociological context which takes note of the other discourses on environmental limits in which discussions of climate change limits are embedded. Additionally, my timeline positions claims of a two degree dangerous limit alongside challenges to this discourse.

2.2 The social construction of danger

This timeline makes use of Bronstein's discussion of the manner in which institutional elites frame workplace dangers. Bronstein, writing about government and industry responses to lung disease in the Appalachian coal mining communities, identifies three stages to the social construction of danger (Bronstein, 1984: 223). Stage one addresses the definition of danger, which in Bronstein's account is a process initiated by the workers and local communities themselves, in the face of official opposition. Stage two involves the authorities legitimating those claims of danger and stage three sees these same authorities co-opting the issue in order to gain control over discussions about what responses are appropriate.

Bronstein's analysis provides some interesting perspectives for the dangerous limit timeline. The timeline can be broken down into three stages which loosely reflect the schema she describes. The time leading up to the formation of the IPCC in 1990 and the formulation of

[2] Books on this topic include an early account from Schneider (1989), popular science books such as Pearce (2007a), Walker and King (2008), more academic treatments, though still designed for a public audience, from Fleming (1998), Weart (2003), and Hulme (2009), and campaigning texts from Monbiot (2007), and Lynas (2006). Films and documentaries featuring historical analysis include the film *An Inconvenient Truth* (2006) and the BBC documentaries *A Hot Planet* (2009) and *Climate Wars* (2009).

United Nations Framework Convention on Climate Change in 1992 equates to the problem definition stage. However, in the case of climate change, the claims of danger were not coming from a range of socially atomized subaltern voices and campaigning organisations, but from the scientific community. This process could therefore be described as something of a lateral and top-down communication process (lateral in the sense of trying to convince other elite actors, i.e. policymakers, of the need to take action. Top-down because of the need for a communication strategy to make the public aware that human activity was changing the climate, and that such changes would in all likelihood be negative). Stage two describes the period from 1993 up to 2004, wherein the ideas of climate danger become increasingly enshrined in the thinking, communications policies and research agendas of various states, most notably those of Western Europe. Climate change also became increasingly important to the work of environmental campaigners during this period, though my research indicates that it was still not a mainstream topic during this period. From 2007, with the EU Energy and Climate Strategy, the G8 commitment to the two degree target, and the Copenhagen Accord, we have entered stage three of Bronstein's model of the social construction of risk, wherein elite actors use the symbolism of the two degree target to take ownership of the debate. It is this construction of climate change as a phenomenon with a single dangerous limit which has entered the mainstream of the political process and public discourse.

However, there is an element to this process which is absent from Bronstein's analysis - what happens when the stage three responses are themselves disputed? The third part of this timeline details the challenges that are beginning to arise to the construction of two degrees of warming as the dangerous limit. Is this development to be understood as a fourth stage, or is stage one of the process beginning again?

2.3 Categorising the three periods of the timeline.

Using Bronstein's categories, the timeline is broken down as follows:

a. Stage 1 - Defining the problem; 1967-1992

Article 2 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) was a pivotal moment in the development of a co-ordinated global response to climate change (Oppenheimer, 2005: 1399) and was the direct forebear of the Kyoto Protocol, the only global agreement on cuts in emissions of CO_2 (King and Walker, 2008: 180). The UNFCCC formalises

the need to avoid dangerous climate change, without actually quantifying what amount of warming should be considered dangerous:

> The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
>
> UNFCCC, Article 2, 1992

This first section of the timeline outlines the events and processes which saw anthropogenic climate change become framed, through the UNFCCC, as a problem with a quantifiable dangerous limit.

b. Stage 2 - Legitimising the claims of danger; 1993-2004

The UNFCCC was in effect a call to climate scientists and policy makers. To climate scientists the convention effectively said, "Climate change is a phenomenon with a dangerous limit, and we have defined the effects that should be considered dangerous. Your job is to find out what levels of carbon dioxide and warming will cause these dangerous effects". As the definition of dangerous impacts provided by the UNFCCC was only 'skeletal' (Oppenheimer, 2005: 1399), this left a lot of work to be done on trying to reduce the uncertainties raised by the UNFCCC. Policymakers from those countries which were signatories to the convention agreed to use the science to develop policies which would ensure CO_2 emissions were kept at a level which would avoid dangerous anthropogenic interference with the climate. By providing resources to intergovernmental bodies such as the IPCC, and acquiescing to the directives from international conventions, states were legitimising the claims of danger and beginning to take ownership of the problems.

c. Stage 3 – Formalising the two degree limit/the consensus breaks down; 2005-2009.

Two conflicting developments have occurred in the two degree dangerous limit story since 2005. One the one hand this idea has, in line with the third stage of Bronstein's analysis, become official policy through the EU's Energy and Climate Strategy (Europa, 2007) and the Copenhagen Accord (2009). Keeping warming at or below two degrees is equated, in the EU,

with legally binding targets of 20% cuts in CO_2 emissions by 2020 and 80% cuts by 2050, against a 1990 baseline (EU Climate and Energy Package, 2008).

Concurrently, there has been an increase in the number of voices challenging the idea that dangerous climate change equates to two or more degrees of warming. Instead, these commentaries argue that the dangerous limit, if it can be defined, is less than two degrees of warming. Additionally, many commentators do not believe it will be possible to avoid more than two degrees of warming, and have begun projecting likely impacts from 4 degrees of warming.[3] Some environmental campaigners are turning away from discussing dangerous limits in terms of two degrees and seek to discuss the problem in terms of atmospheric concentrations of CO_2.

2.4 A broadened approach

Existing discussions of the two degree limit have tended to focus on external top down expert and elite accounts, such as those of climate scientists and policy makers (Lowe and Lorenzoni, 2007: 132). These are undoubtedly important markers in the debate, and feature in my timeline. But they are only part of the story. Any attempt to elucidate the socially constructed features of the two degree limit requires that equal attention be given to the other spaces in, and means by which, the dangerous limits idea is shaped, maintained and communicated.

The approach adopted in this timeline poses a distinct problem, namely how to define what should be included and excluded from the timeline? Additionally, the construction and reproduction of the dangerous limit does not just occur through texts. Face to face discussion in formal and informal settings must also be considered. Whilst it is not possible to include records of past informal discussions, this timeline considers official pronouncements as (albeit distorted) echoes of these conversations. The interview data presented later in this thesis goes some way to providing an insight into the nature and flavour of those 'behind the scenes' debates.

2.4.1 Significance of selected texts

Given that it is not possible to include everything that has been written about the dangerous limit the intention is instead to include what my research, and other analyses, indicate to be

[3]The '4 degrees and beyond' climate change conference held in Oxford in September 2009, and attended as part of the field work for this research, provides a useful synthesis of the thinking on the prospects of four degrees of warming. <http://www.eci.ox.ac.uk/4degrees/programme.php>. Accessed 16th June, 2010.

the most significant contributions to the construction of the two degree limit. Establishing what counts as significant will always be arbitrary, but it is possible to establish meaningful criteria for defining which discourses have had an impact on this debate.

In the first instance it is necessary to adjudicate between different types of commentary; for example comments on a blog may be read by more people than would read an article in an academic journal. A message heard by ten members of the public might be considered to be less significant than one listened to by ten heads of state. We might therefore ask - what size of audience counts as significant? What sort of audience counts as significant? Is a statement significant simply by virtue of making it into print? A non-academic book on climate change which addresses an audience of engaged actors who might then go on to influence others should be considered significant even if it is not presenting new information in the way academic research does.

Rather than seeking to attribute significance solely on the basis of audience size for any particular commentary, the first criteria this timeline uses is to include only those commentaries that have gone through some sort of peer review process. This might be in the form of an editor checking media stories or book contributions, communication professionals revising official policy announcements, or a peer review community critiquing journal submissions. In other words, these are formal or official texts, which are grouped into three main categories:

- Policy. The significance of policy is considered self-evident in that it, theoretically at least, ushers in legally binding rules and/or changes to the practices of particular institutions.
- Climate science. Developments in climate science may be articulated through press releases, journal papers, NGO campaigns, popular science books or reports which straddle the policy/science divide.
- Media stories. I provide a detailed qualitative analysis of media representations of the two degree limit later in this thesis. I cannot meaningfully select from all the media stories on this subject and decide which have had the most impact.[4] Instead I restrict myself to a quantitative record of the number of mentions of the two degree limit in the UK news media.

[4] I make one exception; a shared front page editorial published in 56 newspapers around the world on the eve of the Copenhagen Summit, calling on the attendees to agree a two degree limit.

Another criteria of relevance to this schema regards the intent of the statement - was the statement designed to influence perception, attitudes and/or behaviour towards the dangerous limits idea? Discourse which is designed to impact the dangerous limits debate would need to be saying something new, saying something already known but in a different way, in different circumstance or in a different medium (and thus to a new audience). It may be that the significance and potential for affect is the consequence of being said by someone or some group which has not previously engaged in the discourse. Of course the influence of any statement could be the combination of more than one of the above attributes.

In summary, significant events, statements and discourses about dangerous limits to anthropogenic forcing of the climate are defined as those which, as a minimum:

- Assume that industrial activities are causing changes to the climate which would not otherwise occur
- Are deliberate communicative acts
- Have some persistency
- Are designed to affect some kind of cognitive or policy change.

2.4.2 Relationships between the selected texts

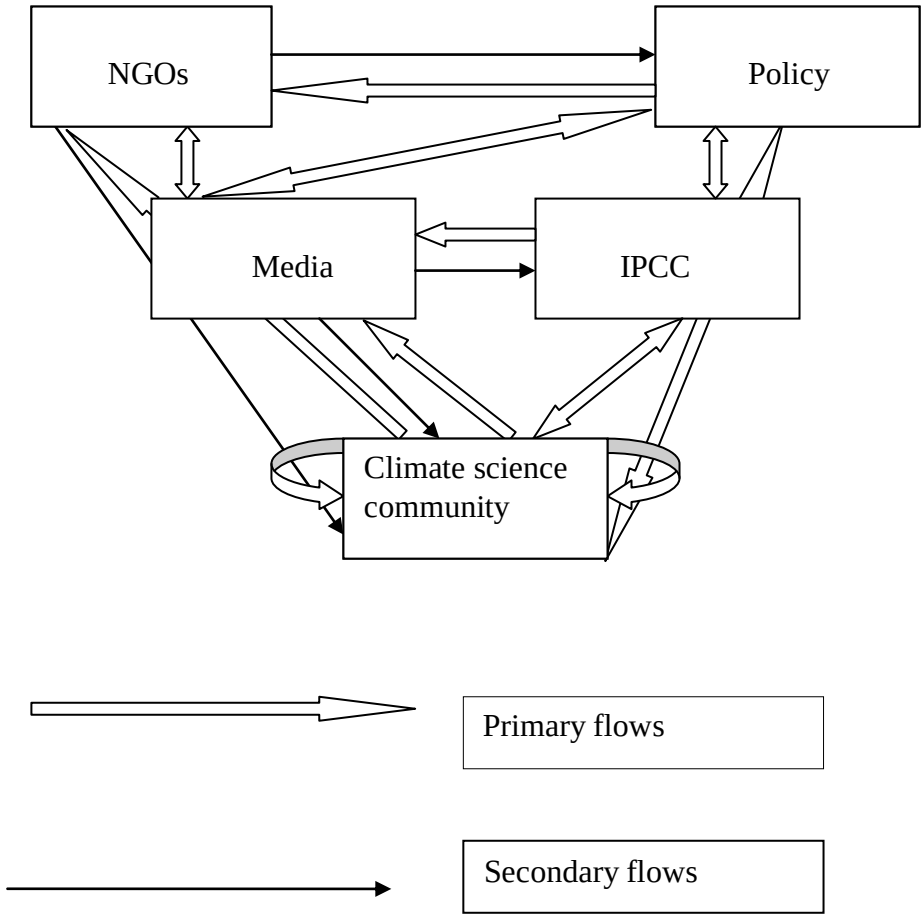
The process of identifying significant commentaries is aided by an explanation of the relationships between the various discourses, to help explain how, directly or indirectly, these might influence each other. *Figure 1* (below) lays out, in a simple form, the movement of information and ideas between the different communities in the dangerous limit debate.

I have differentiated between primary and secondary flows of information, with the larger arrows representing the primary flows.

i) Primary flows

Climate science provides the majority of the data and knowledge informing climate change discourse. Hence climate science is identified as providing a primary flow of information to all other parties. This is not to argue that all climate science papers and research will have a significant impact, only that climate science is a source of significant discourses. There is also a belief that climate science, through the auspices of the IPCC, shapes government policy.

Figure 1: Flow of discourse between different climate change communities.



The extent to which governments do actually respond to climate science is disputed. Nonetheless, the IPCC is intended to mediate between climate science and policy makers. However, the IPCC has only issued four assessments since 1990 (1990, 1995, 2001 and 2007). Therefore the state requires other channels for the ongoing transfer of climate science. An example of just such a channel is the conference called in 2005 by the then UK Prime Minister Tony Blair, and hosted by the Meteorological Office, which was intended to define dangerous climate change (Blair, Schellenhuber, Cramer, and Nakicenovic, 2005). Additionally, several studies indicate that an audience of immediate concern to many climate scientists is other scientists working in their area of expertise (Boehemer-Christiansen 1994; van der Sluijs, van Eijndhoven, Shackley, and Wynne, 1998.)

I argue in this thesis that the environmental campaigning community is an important agent for the construction of the dangerous limit, and is a community which relies heavily on scientific evidence to promote its cause. This relationship is illustrated by the recent formation of a new

NGO in the United States (www.350.org), the genesis of which lies in a series of papers and pronouncements by the climate scientist James Hansen, which argued that the dangerous limit should be defined in terms of atmospheric concentrations of CO_2 of 350ppm. The media are identified as being of primary importance to environmental campaigners because the political economy of the media defines what representations of the dangerous limit will be accepted and carried by the media, thus shaping how environmental campaigners construct their representations of the dangerous limit.

The diagram features a two way primary flow between the media and policy. Policy changes are a prominent feature of news stories, and public perception of the state is heavily influenced by media coverage. Policy statements which aim to impose restrictions on people's activities in order to achieve reductions in emissions of CO_2 are given prominent coverage and the way such potentially unpopular policies are presented will likely be of key concern to the incumbent political party. The remaining primary flow is from policy to environmental campaigners. Their campaigns will often be a reaction to government policy. The climate camp protest at Heathrow Airport in the summer of 2007 was ostensibly a reaction to government plans to build a third runway at Heathrow, and the protest at Kingsnorth power station in 2008 was in response to government plans to build more coal fired power stations.

The IPCC assessments include summaries for journalists, and therefore are identified here as providing a primary source of information to the media on the dangerous limit.

ii) Secondary flows

The climate science community is identified in *Figure 1* as subject to two secondary flows, from the media and campaigners. The extent to which discussions of dangerous limits within the climate science community have been constrained or defined by external social norms is difficult to assess. However, any such influence, if it exists at all, may partly be mediated through external discourses coming from environmental campaigners and the media.[5]

The IPCC collates, interprets and disseminates peer reviewed climate science, and its own peer review panel is comprised, in part at least, of climate scientists. As with the climate science community, the IPCC is deemed to be comprised of socially situated actors. For example Agrawala (1998) argues that the findings of the IPCC reflect an internalisation of the requirements of the policy making community. The IPCC finds it necessary to reflect these

[5] The 'climategate' 'scandal' of late 2009 led to a range of official hearings which resulted in the call for changes in the storing and sharing of scientific climate data. What other, more informal, impacts such a media storm has had on the conducting and communicating of climate science is as of yet difficult to ascertain.

requirements in its quest for international legitimacy. A secondary flow is shown between the media and the IPCC on the assumption that the media will have a role to play in the maintenance of the IPCC's legitimacy, and thus the findings of the IPCC will be sensitive to the way the assessments will be reported by the media.

The extent to which climate change policy is influenced by the demands of environmental campaigners is unclear. However, when in power the then UK Climate Change Secretary, Ed Milliband, called for a climate change social movement in order to give government the support it seeks for its climate change policies (Hinsliff and Vidal, 2009). For this reason I have identified the state to be subject to some degree to influence from campaigners.

Absent from this schema is the impact of business and special interest lobbying intended to limit the extent or impact of climate change policies on the economic status quo. This is because whilst such groups are very active, and are deemed to be highly influential (Boykoff and Boykoff, 2004) they do not generally critique the two degree limit, and instead focus on more general debates about the existence of anthropogenic forcing of the climate, the severity of the impacts, and what amount of economic growth should be sacrificed in the name of climate change.

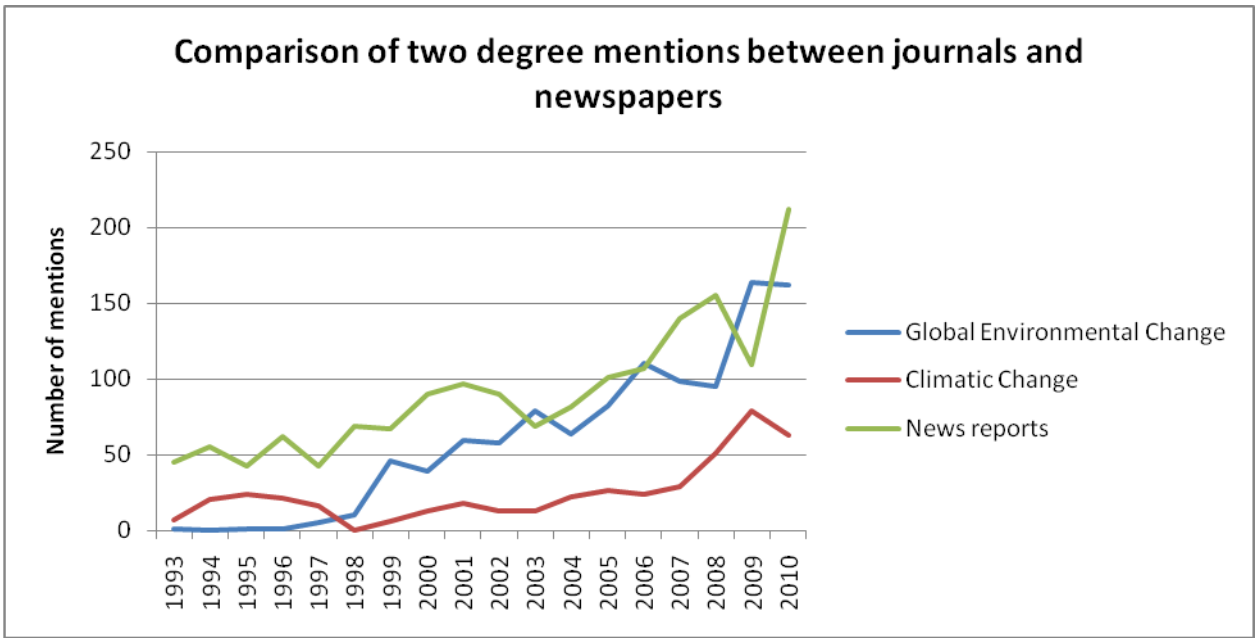
2.5 Frequency of mentions of two degree limit in UK news media

Figure 2 and *Figure 3* (below) show how number of references to the two degree limit has fluctuated over the period of this timeline. *Figure 3* breaks down the trend shown in *Figure 2* by separate UK newspaper titles. As one might anticipate, there are many more mentions in the broadsheet press than tabloids. I first discuss the patterns in coverage of the two degree limit shown in *Figure 2*.

2.5.1 Comparison of frequency of media reports with selected journal coverage

Figure 2 illustrates how the number of news stories and academic papers mentioning the two degree limit has varied since the UNFCCC came into force.

Figure 2: Comparison between newspapers and journals of number of mentions of 'two degrees'.



The newspapers reports were all those that came up in the search of the Lexis-Nexis database using the words "two degrees" and "2 degrees". I used these same search term for two academic journals - *Global Environmental Change* and *Climatic Change*.[6] These are both leading journals in climate change studies, and include papers from the natural and social sciences. Other journals could have been included, but there is nothing to indicate that the pattern in the coverage of those journals would differ substantially from that shown here.

The trend across the three categories is broadly similar, i.e. a rising trend. This is surprising given the different responsiveness of journals to news reports. News reports are much more immediate; it can take two or more years for an article to be printed following its initial submission to the journal. I would expect the dip/levelling off in the journal count at the end of the period measured to show a rise in the next two years to match that shown by the news reports as the implications of the Copenhagen Accord and 'climategate' are investigated in these journals.

Though claims for a two degree dangerous limit were being made from the early 1990s, it would seem from *Figure 2* that such debates were of little interest prior to 2005. For news reports this can in part be explained by the absence of any event or personality driven story lines around which such a discussion could be held. Another explanation may be that for both

[6] The following information comes from the 'About' pages for these journals. Global Environmental Change has an impact factor of 3.34 for 2010 and ranks 3rd out of 66 environmental journals. Climatic Change has an impact factor of 3.635 for 2009 and ranks 20th out of 163 journals in environmental sciences.

academic journals and news channels the debate was as much about establishing the empirical truth of anthropogenic climate change. Achieving consensus on this must necessarily be a precursor to consideration of how much human interference with the climate is too much. An additional barrier to academic examination of the dangerous limits issue might be structural, i.e. due to an absence of funding streams. And yet, the UNFCCC had in 1992 established the idea of dangerous climate change, whilst leaving dangerous undefined. Identifying dangerous limits to climate change, given the gravity of the projected consequences, would seem an issue worthy of immediate and urgent attention. Evidence of such attention is absent from the pattern in *Figure 2*.

A simplified version of the tripartite chronological division employed in the timeline below can be applied to the information shown in *Figure 2*. Simplified because instead of a threefold division, we can adopt a simple dichotomous split between the periods leading up to and including 2004, and then a second period, from 2005 until the current day. I split the timeline in this way for discussion of the pattern in Figure 2 because over the seventeen year period analysed, 57% of the stories/papers mentioning two degrees appeared in just the last five years, from 2005 until now. Thus the year 2005 is treated as a watershed in discussion of the two degree limit, at least quantitatively.

Why was 2005 such a watershed year in coverage of the two degree limit? Firstly, and most importantly (at least at a global scale) 2005 was the year in which the Kyoto Protocol was ratified. Though the emission cuts mandated were not explicitly derived from the need to avoid a definitive dangerous limit, it appears that in reporting and analysing the implantation of the protocol, mention of the two degree limit would have been swept up along with other discussion of other elements of the climate change debate in this coverage. A second, more UK specific event, was the conference called by Tony Blair in 2005 with the intention of defining a dangerous limit to climate change. Though there was no statement from the conference defining two degrees as a dangerous limit, there is frequent mention of impacts at two degrees in the conference output documents. This was followed by the release of the 4th IPCC Assessment report in 2007, the adoption of the two degree limit by the G8 in 2009, and the Copenhagen Accord of 2009.

I argue that Latour and Woolgar's idea of black boxing can help explain the near media silence on the two degree limit up to 2005. Black boxing describes how the ideas, debates and controversies that attend to the development of facts are hidden away. If the "fact" works, then it is used without examination of, or concern for, the ideas on which the "fact" rests. Such occlusion of the back story is also an important part of defining the idea as fact, because removing the idea from its social context reinforces the sense of objectivity. Whatever

attempts to agree a dangerous limit were happening, such issues were of marginal interest to the media and academic communities. By the time discussion of the two degree dangerous limit was being articulated in public discourses it had already taken on the status of fact. It is difficult to make any definitive claim as to the purposeful nature of this neglect. Yet there is one element of this timeline which is difficult to explain if one accepts the idea that the climate change debate was, pre-2005, an open and honest one. That problem is the absence of any spike in discussion of the two degree limit immediately following the European heat wave of 2003. Simple logic combined with sensitivity to the debate might have been expected to lead to a vociferous and public discussion of just how safe two degrees of warming is.[7] This episode arose against a global average increase in temperatures of 0.7 degrees centigrade over pre-industrial, approximately 33% of the rise deemed a dangerous limit. Yet the heat wave was responsible for an additional 30,000 deaths in Europe. How could an almost threefold increase of that temperature rise still be considered safe? Given the significance of the negative impacts projected to arise from climate change, how could such a question be ignored?[8] This timeline, in combination with the qualitative analysis of the data collected for this research, will go some way to answering that question.

2.5.2 Comparison between different newspaper titles

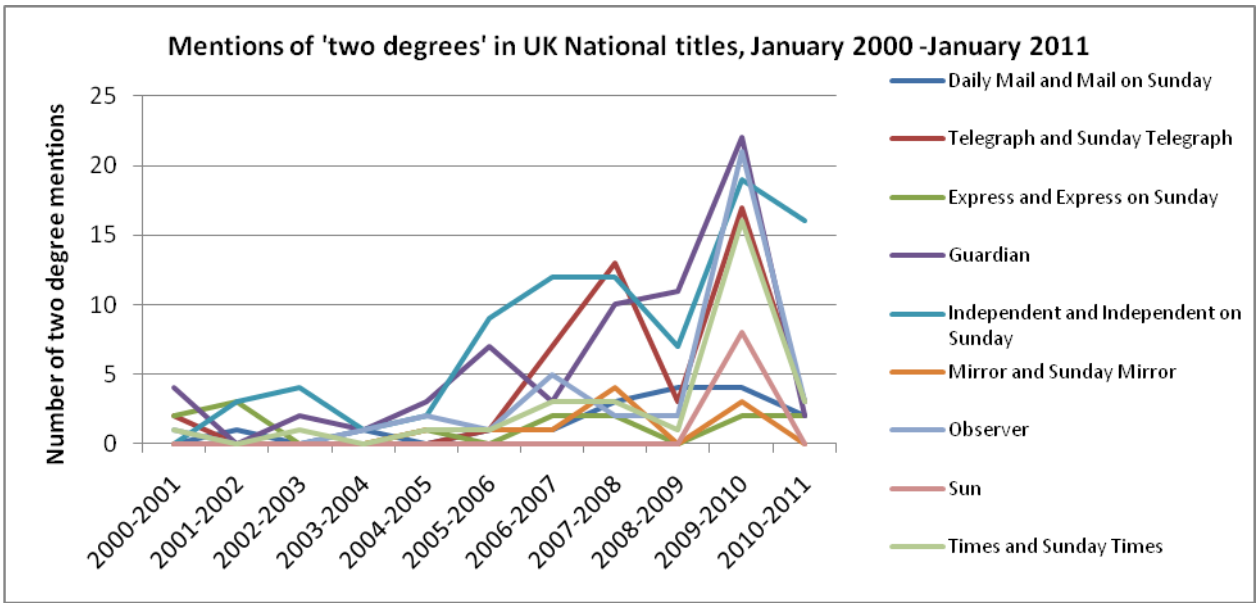
Figure 3 (below) shows that there was an increase in coverage of the two degree storyline in 2009, though the biggest peak was in the more liberal broadsheets (*The Guardian, The Independent, The Independent on Sunday* and *The Observer*). However, the more right wing *Daily Telegraph* and *The Times* both show a sharp peak in the number of references to two degrees at this same time. *Figure 3* (below) includes data from January 2010-January 2011.

This data shows a sharp drop off in discussion of the two degree limit. The elite theory framework I employ in my research argues that the media acts as an echo chamber for the agenda and opinions of elite actors and institutions. My findings support that approach; the media are interested in the two degree limit only in so far as it is discussed by global elites.

[7] My qualitative analysis did pick up three examples in the press of mentioning two degrees of warming in relation to the European heat wave, but only to note that the heat wave equated to summer temperatures across Europe two degrees higher than the average for that time of year.

[8] Mark Lynas, an environmental campaigner and journalist, was able in 2004 to complain that climate change only occasionally makes the media, and is 'studiously ignored' by television (296).

Figure 3: Distribution of two degree quotes across UK newspaper titles.



When these actors stop talking about it, so does the media. Elite actors only talked about the two degree limit in so far as it was necessary to justify the decision they made at Copenhagen. From that point on it becomes fact, and is enshrined in policy. All that is left to discuss is how to best achieve the target, not the target itself.

2.6 Timeline: 1967-1992

Table 1: Key milestones leading to the formulation of the UNFCCC statement on dangerous climate change.

Year	Event	Notes
1967	Paper by Mannabe and Weatherald.	Provides 'a convincing calculation that a doubling of CO_2 would raise temperatures by roughly 2 degrees centigrade'. (Cited Weart, 2003: 203). Appears to be first discussion of climate sensitivity in the academic literature.
1972	*Limits to Growth* (Meadows, Meadows, Behrens and Randers).	Popularized idea of environmental limits. 4 million copies sold in 4 years.
1976	*The Genesis Strategy: Climate and Global Survival.* (Schneider, S.H). Bach; paper in *Global Air Pollution and Climatic Change.*	Specific reference to the concept of crossing a threshold of climate danger (p11). Asks 'How much impact can be permitted before the balance of nature is seriously upset?' (p431).
1977	National Research Council: Studies	Foreword to report asks 'What *should* the

	in geophysics: *Energy and Climate*.	atmospheric carbon dioxide content be over the next century or two to achieve an optimum global climate?' (p9).
1979	Nordhaus, W.D.	First study to systematically address issues of dangerous limits to climate change. Argued the climate effects of carbon dioxide should be kept within the 'normal range of long-term variation', namely 2 degrees centigrade above pre-industrial average.[9]
1985	Villach Conference.	Projects likely future scenarios according to differing rates of emissions. Declares agreements to restrict emissions should be considered. Recognised need for indicators/targets (Rijsberman and Swart, 1990: vi). Described as establishing the 'hegemony of the natural sciences in the way climate change would subsequently be presented to the policy world' (Hulme, 2008: 6).
1986	Advisory Group on Greenhouse Gases (AGGG) formed.	Precursor to the IPCC. Was dissolved to make way for IPCC. AGGG had sought to set 'tolerable limits'. Was seen as too politicised (Agrawala, 1998).
1987	U.S. Global Climate Protection Act.	Mandated that US policy should seek to 'limit mankind's adverse effect on the global climate by (a) slowing the rate of increase of concentrations of greenhouse gases in the atmosphere in the near term; and (b) stabilizing or reducing atmospheric concentrations of greenhouse gases over the long term'. (Title 15: Chapter 6).
1988	World Meteorological Organization.	Report proposed that a target framed in terms of a rate of warming would provide a useful long-term objective (called a tolerable rate) for limiting emissions. Augmented by a proposed limit of one or two degrees Celsius on total global warming (Oppenheimer and

[9] Jaeger and Jaeger cite two Nordhaus papers as the source of the two degree limit, from 1975 and 1977 (2010: 6). The approach used by Nordhaus in his 1977 paper follows the back casting approach employed by the WBGU. Thus two degrees represents the upper limit of natural variability over the last 100,000 years (see Jaeger and Jaeger, 2010: 7 for a reproduction of a graph used by Nordhaus in support of his claims for a two degree target). Jaeger and Jaeger go as far as to draw a direct correlation between the 2 degree aside in the 1977 Nordhaus paper with Adam Smith's fleeting mention of the 'hidden hand of the market' metaphor. Both were inconsequential remarks made by economists which have had far reaching consequences (2010: 8).

		Petsonk, 2005: 205).
	Toronto Conference.	Conference statement released, titled 'The changing atmosphere: Implications for global security'. Calls for 20% cuts in global CO2 emissions by 2005 (Hulme, 2008: 64).
	James Hansen gives presentation to US congress in which he ascribes the heat wave in the US of that year to global warming.	Seen as the moment that climate change made it on to the front page of US newspapers (Leisorowitz, 2005: 1435).
1989	Enquette Commission.	Proposed an 80% reduction in fossil-fuel use by 2050 to avoid a warming of one-to-two degrees Celsius (Enquette Commission, 1989).
	Noordwijk ministerial conference.	Professor Bolin, IPCC chairman, notes that "business as usual" is dangerous, but conference avoids recommending emission targets in absence of sufficient scientific evidence. (Noordwijk Declaration on Atmospheric Pollution and Climate Change).
	Paper by Krause *et al.*	Introduces the concepts of 'unprecedentedness (sic) and climatic throwback' to deduce targets for temperature change (Cited, Rijsberman and Swart 1990: 23).
1990	Second World Climate Conference.	Issues a declaration that 'the ultimate global objective should be to stabilize greenhouse-gas concentrations at a level that would prevent dangerous anthropogenic interference with climate' (p220).[10]
	Stockholm Environment Institute.	Report commissioned for the AGGG (the precursor to the IPCC) argued for maximum rate of warming of 0.1 degrees centigrade per decade and an overall maximum warming of between 1 and 2 degrees centigrade, depending on the agreed level of risk (Rijsberman and Swart, 1990: viii). Report cited in IPCC 2007 WGIII (Parry et al., 2007:

[10] The conference was widely seen, at that time, as a failure because there was no agreement on targets for emission reductions. This was believed to be necessary to ensure the US stayed on board with a process which culminated in the UNFCCC of 1992 (see New Scientist, November 17th 1990, for an example of this viewpoint).

	IPCC First assessment report.	99) as early definition of two degree target. Did not state particular stabilization targets for atmospheric concentrations of CO2[11] (Houghton et al., 2001).
1992	UNFCCC.	Convention requires signatories to reduce emissions to level which will avoid dangerous climate change (UNFCCC, Article 2).

2.6.1 Commentary on *Table 1*

Oppenheimer and Petsonk (2005) have provided a scientific, legal and political history of Article 2 of UNFCCC. Their history examines the debate leading up to the formulation of Article 2 and subsequent discussions of its interpretation and implementation. They trace a growing interest in the prospect of a dangerous threshold to climate change to the mid 1970's (2005: 196 and references therein). Though elements of Oppenheimer and Petsonk's account is challenged by other authors (for example Tol, 2007 and Flannery, 2006) there seems to be broad agreement that the limits idea first made it into print in the mid to late 1970's. Research by the economist W.D. Nordhaus published in 1979 is cited by Oppenheimer and Petsonk as the first systematic treatment of the questions being raised in the mid-1970's, wherein two degrees of warming is described as a 'reasonable' limit as it reflects the maximum warming experienced within the range of long- term natural variations over the last 10,000 years (2005: 197).

The next significant milestone in the two degree limit story comes with the Villach conference of 1985. The conference has been described as important for a number of reasons; it was an event which developed an influential scientific consensus (Oppenheimer and Petsonk, 2005), served as a precursor to the IPCC (Boehmer-Christiansen, 1994) was a major step in joining climate science with climate policy (van der Sluijs et al., 1998) and represented the first authoritative evaluation of the magnitude of climate change (Flannery, 2005).[12] Though the conference did not set any targets for cuts in emissions of CO_2, it was a precursor to the World Meteorological Organization's report of 1988, which quantified dangerous limits in terms of rate of warming (1/10th of a degree Celsius per decade) and an overall upper limit to warming of one to two degrees Celsius (Rijsberman and Swart, 1990). This was followed by the Toronto

[11] In fact none of the IPCC reports make claims for a two degree limit. However, I include the reports in this timeline because the IPCC reports are sometimes referred to as the source of the two degree dangerous limit.

[12] However, see the discussion chapter for details of a claim that the Villach Conference and outputs were the work of industrial interest groups seeking to avoid radical responses which would damage their profit seeking activities.

Conference of 1988, which sought to set targets predicated on political and economic considerations, rather than environmental ones and concluded that a 20% reduction in industrial countries' emissions of carbon dioxide from 1988 levels by 2005, was required (ibid). This target contrasts with the German Enquette Commission's report, which called for an 80% reduction in CO_2 emissions to avoid a 2 degree rise but, contrary to research being conducted in Holland and the US, did not make any reference to long range stabilisation targets.[13] These two approaches (cuts in emissions and long term stabilisation targets) were brought together in the IPCC report of 1990, which also recommended a framework convention along the lines of that used to co-ordinate responses to the problem of ozone pollution in the 1980's. Concurrent with these attempts to quantify a dangerous limit were discussions which sought to achieve a legal agreement that certain impacts should be avoided, without attempting to quantify particular limits. A 1989 ministerial conference in Noordwijk, Holland, which proposed that climate change be kept within 'tolerable limits' (Swart and Vellinga, 1994) and the second World Climate Conference of 1990, which stressed the need to avoid dangerous interference with the climate, have been identified by Oppenheimer and Petsonk as the antecedent to the UNFCCC statement of 1992 (2005: 202).

Alongside these conference reports the Swedish government commissioned a terms of reference report to address the topics coming out of these conferences (Rijsberman and Swart, 1990). The Rijsberman and Swart study, based on environmental objectives, actually proposes two different limits to warming; either one degree *or* two degrees depending on which levels of risk are deemed acceptable (1990: viii). The one degree limit will secure a future of low risk from dangerous climate change, the two degree limit would usher in a world at high risk of dangerous climate change (ibid).

It is therefore apparent that several reports and conferences had concluded that an upper limit of two degrees of warming might equate to a dangerous limit. Yet the UNFCCC statement made no reference to these figures. Roberts (2002) has argued that this was at the behest of the US, which would not sign up to any convention which quantified the dangerous limit. The next part of the timeline looks at how the convention's qualitative description of dangerous climate change has been responded to.

[13] Long term stabilisation targets differ from short range emission cuts because the former is asking "What is the end goal? What concentrations of CO_2 do we wish to end up with – are we aiming to return the atmosphere to its natural state or is the plan to permanently stabilize concentrations of CO_2 at a higher than natural level?"

2.6.2 Timeline: 1993-2004[14]

Table 2: Key events following the UNFCCC statement.

Year	Event	Notes
1994	Dutch National Research Programme.	Identified 2 degree limit (Cited in Oppenheimer and Petsonk, 2005: 204).
	IPCC Special Workshop on Article 2 of the UNFCCC.	Confirmed that it is not the IPCC's job to define dangerous climate change as it involves consideration of economic and social factors outside of its remit (IPCC, 1994).
1995	WBGU - Statement on the occasion of the First Conference of the Parties to the Framework Convention on Climate Change in Berlin.	Simultaneous application of several criteria to limit choice of emissions pathways (Tolerable Window Approach). Calculates 2 degrees as tolerable limit.
	IPCC 2nd Assessment report.	Generates range of emission scenarios, mid-range assumes 2 degrees warming by 2100 (Kattenberg, 1995).
1996	1939th EU council meeting.	'The Council believes that global average temperatures should not exceed 2 degrees above pre-industrial level'.
1997	WBGU - A Study for the Third Conference of the Parties to the Framework Convention on Climate Change in Kyoto.	Reconfirms 2 degree limit.
2001	IPCC Third Assessment Report.	Saw attempts to define dangerous climate change as beyond its legal remit (Dokken, Nogue, van der Linden, Johnson and Pan, 2001).
	'No one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided'.	U.S. President George W. Bush, 11th June 2001.
2003	WBGU - Climate Protection Strategies for the 21st Century. Kyoto and Beyond.	Calls on EU to set the lead by committing to limiting warming to 2 degrees.
	European heat wave.	30,000 excess deaths in Europe (UNEP, 2004).

[14] There were no events identified for 1993.

2004	2610th EU Council Meeting.	Report argues 'the maximum global temperature increase of 2°C over pre-industrial levels should be considered as an overall long-term objective to guide global efforts to reduce climate change risks in accordance with the precautionary approach'.

2.6.3 Commentary on *Table 2*

The period from 1994 to 2005 saw the idea of the two degree dangerous limit become increasingly prominent in the policy/science literature and conference outputs (though as Figure 2 has shown, this activity was not reflected in news reports and commentaries). The German Advisory Council on Global Environmental Change (WBGU) reports of 1995, 1997 and 2003, are seen as important markers in the dangerous limit debate during this period.[15] The WBGU papers were commissioned by the German government and fed directly into the UNFCCC process and the first Conference of the Parties (WBGU 1995), the creation of the Kyoto Protocol (WBGU 1997) and current EU policy (WBGU 2003). Tol argues that the 1995 WBGU paper marks the first appearance of the two degree target (2007: 425), an assumption challenged by the first part of this timeline. However, it may be the first appearance of the target in a publication directly concerned with the development of environmental policy.

The WBGU report of 1995 was intended to inform deliberations at the First Conference of the Parties to the Framework Convention on Climate Change in Berlin. This conference was seen as important '…not only by the fact that the Convention has been signed by the minimum number of states (50), but that it has already been ratified by a total of 121 states and the EU as of February 1995' (WBGU, 1995: 3). The report sought to quantify the dangerous limit, and outline how such a limit could be avoided through the adoption of a 'tolerable windows approach' (TWA)[16]. There are two key principles used to calculate the TWA – 'preservation of Creation in its current form' (WBGU, 1995: 13) and 'the prevention of excessive costs' (ibid).

[15] Jaeger and Jaeger, alongside Tol (2007) and Oppenheimer and Petsonk (2005), all agree about the importance of the WBGU reports. Jaeger and Jaeger argue it was these reports, and the efforts of the WBGU's chairman, Joachim Schellenhuber, which convinced Angela Merkel to push for the two degree target at international conferences. For these authors the WBGU reports 'did indeed trigger the political process that fifteen years later led to the global visibility conferred to the 2° target by the G8, the Major Economies Forum, and the Conference of the Parties held in 2010 in Copenhagen' (2010: 7).

[16] The TWA first defines the end point (the limit to be avoided) and identifies the CO_2 concentrations which equate to this limit. A calculation is then made of year on year emission cuts required to avoid the TDL. Various scenarios are presented, according to when exactly the process of cutting emissions begins. The longer the delay in beginning the cuts, the larger the year on year cuts required.

In fact, despite the claims to be an advance on previous attempts to define a dangerous limit, the WBGU bases its first principle on the work carried out by Nordhaus in 1979. The TWA:

> is derived from the range of fluctuation for the Earth's mean temperature in the late Quarternary period. This geological epoch has shaped our present-day environment, with the lowest temperatures occurring in the last ice age (mean minimum around 10.4 °C) and the highest temperatures during the last interglacial period (mean maximum around 16.1 °C). If this temperature range is exceeded in either direction, dramatic changes in the composition and function of today's ecosystems can be expected. *If we extend the tolerance range by a further 0.5 °C at either end, then the tolerable temperature window extends from 9.9 °C to 16.6 °C.* Today's global mean temperature is around 15.3 °C, which means that the temperature span to the tolerable maximum is currently only 1.3 °C.
>
> WBGU, 1995: 13, emphasis added[17]

The 1997 WBGU report to the Kyoto Conference reconfirms the basic premise which informed its 1995 report, but identifies the emissions targets as becoming more restrictive because of the need to include other greenhouse gases besides CO_2. Despite these recommendations, the Kyoto conference could only agree cuts in emissions so small as to be 'irrelevant' (Flannery, 2005: 224). Perhaps the true heir to the WBGU reports is the EU Climate and Energy Strategy, which seeks to introduce legal instruments for ensuring cuts in emissions sufficient to avoid breaching the two degree dangerous limit. King and Walker (2008) claim that this policy can be directly linked to the call in the 2003 WBGU paper for the EU to take a lead in limiting warming to 2 degrees centigrade (WBGU, 2003: 2).

2.6.4 Timeline: 2005-2009

In this final part of the timeline I include challenges to the two degrees concept alongside statements reiterating the belief that two degrees is a dangerous limit. I have not included

[17] This addition of 0.5 degrees is an important step in defining dangerous climate change as two degrees of warming. Rather than defining the limit on the basis of projected impacts derived from computer models, the WBGU back casts to previous climate regimes, and then adds another 0.5 degrees to reach the two degree target. The additional 0.5 is based on the assumption that humanity is better able to adapt to climate change than our hunter gatherer forbears (WBGU, 2003: 9). This is a problematic assumption, not least because it is unclear how one can quantify this difference in adaptive capacity. It seems equally arguable that hunter gatherer societies, in being less reliant on complex inter-dependent technologies and extended production chains for the provision of essentials such as food and power, would better be able to adapt to the impacts of climatic changes.

such challenges before simply because, asides from George W. Bush's 2001 statement I have not been able to identify any from before 2005.

Table 3: Two degrees in public and policy discourses.

Year	Event/statement	Notes
2005	Kyoto Protocol ratified.	First treaty to commit signatories to taking first steps towards emission cuts required to avoid dangerous climate change (UNFCCC, Kyoto Protocol Fact Sheet).
	Defining Dangerous Climate Change conference, Exeter University.	Conference called by Tony Blair to quantify a dangerous limit to climate change.
	Hansen, J. Director NASA Goddard Institute for Space Studies.	'The two degree scenario cannot be recommended as a responsible target, as it almost surely takes us well into the realm of dangerous anthropogenic interference with the climate system' (2007: 278).
	Meeting the Climate Challenge.	Recommends limiting warming to no more than two degrees (UK International Climate Change Taskforce, 2005).
	Council of the European Union.	'overall global annual mean surface temperature increase should not exceed 2°C above pre-industrial levels' (Presidency Conclusions: 15).
2006	'An Inconvenient Truth' released.	Oscar winning climate change documentary. Does not mention the two degree limit.
	Stern Review.	Uses a cost-benefit analysis to recommend a 550ppm target. Widely claimed to equate to 3 degrees of warming (HM Treasury).
2007	Pachauri, R. Head of the Intergovernmental Panel on Climate Change.	'People are actually questioning if the 2 degrees Centigrade benchmark that has been set is safe enough' (Pachauri, Reuters).
	EU Commission communiqué.	'Climate change is happening. Urgent action is required to limit it to a manageable level. The EU must adopt the necessary domestic measures and take the lead internationally to ensure that global average temperature increases do not exceed pre-industrial levels

		by more than 2°C' (Europa, 2007).
	Legitimacy of EU target challenged.	Tol (2007) critiques methodology employed in WBGU study.
	President of the American Association for the Advancement of Science questions two degree target.	'I think that 2 degrees is rather arbitrary. It's not clear to me that the answer shouldn't be three degrees, or more, or less. We don't have a scientific basis for selecting the two degree number - it's a hunch, a guess' (Marburger, 2007).
	IPCC 4th Assessment report. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.	'Defining what is dangerous anthropogenic interference with the climate system and, consequently, the limits to be set for policy purposes are complex tasks that can only be partially based on science, as such definitions inherently involve normative judgements' (97). There are different approaches to defining danger, and an interpretation of Article 2 is likely to rely on scientific, ethical, cultural, political and/or legal judgements (99). (Metz, Davidson, Bosch, Dave and Meyer, 2007).
	Conservative Party Quality of Life Commission.	'Don't give up on two degrees' report aimed at policymakers argues for the two degree limit (Hurd and Kerr, 2007).
2008	New NGO formed on basis of James Hansens' comments that there are already dangerous levels of CO_2 in the atmosphere.	www.350.org
	4 degrees and beyond – Implications of a global climate change of 4+ degrees for people, ecosystems and earth-systems.	International conference, Oxford.
2009	G8 Chairman's statement.	'We recognize the scientific view that the increase in global average temperature above preindustrial levels ought not to exceed 2 degrees C' (G8, leader's declaration).
	UNFCCC Copenhagen Accord.	'to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with

		the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius, on the basis of equity and in the context of sustainable development, enhance our long-term cooperative action to combat climate change' (UNFCCC Draft Accord).
	UK low carbon transition plan.	Government document confirms two degree target.
	The Major Economies Forum on Energy and Climate set up.	Launched in 2009, backs a two degree limit (Major Economies Forum on energy and climate: Declaration of the leaders the major economies forum on energy and climate).
	Smith et al.	Academic paper revisits 'Reasons for concern diagram' (burning embers), arguing that dangerous climate change begins below two degrees .
	AVOID formed.	A UK research programme that provides key advice to the UK Government on avoiding more than two degrees of warming. <http://www.avoid.uk.net>
	Shared editorial in 56 newspapers on eve of the Copenhagen Summit.	'The science is complex but the facts are clear. The world needs to take steps to limit temperature rises to 2C' (The Guardian, December 6th, 2009).

2.6.5. Commentary on *Table 3*

This third part of the timeline shows that since 2005 there has been an increased focus on defining how much climate change is to be considered dangerous. The pattern apparent in this timeline follows Bronstein's model. In the first instance there is a process by which the phenomenon of anthropogenic climate change becomes framed as a problem of sufficient magnitude to require intergovernmental recognition, funding and support. The setting up of these institutions and development of the relevant treaties constitutes the second part of the social construction of the problem, namely its legitimation. Out of the stage two processes comes ownership of the risk, and reassurances that the formal bodies are managing the risk. This is exemplified by the agreement of a two degree dangerous limit. Yet, even as attempts

are made to secure ownership of the problem, culminating in the Copenhagen Accord of December 2009, other voices are suggesting that it will not be possible to stay under two degrees of warming and that in any case two degrees may not prevent dangerous climate change.

Chapter 3

Literature Review

3.1 Introduction

This literature review is broken down into three broad topic areas. The first section addresses the debate around uncertainty, which is such a prevalent feature of the climate change debate. Discussions of uncertainty in climate change projections provide the context for the focus of this research, namely an investigation of how a dangerous limit can be identified with such exactitude, given these uncertainties.

The second section examines how the theories of risk have been used to justify the two degree limit. Risk is understood to be the means by which policy can be made and justified under conditions of uncertainty. I examine the literature analysing the role of subjectivity in these ostensibly rational and objective calculations, and the relationship between the metrics of environmental risk analysis and the setting of a dangerous limit to climate change.

In the third part of the literature review I examine how the academic literature has sought to define dangerous climate change. I split this into two categories; definitions based on quantifiable, physical changes against definitions which reflect the cultural and social dimensions of dangerous climate change.

This literature review, by demonstrating the respective roles of values and empirical measurements in elaborating future climate change scenarios, provides an explanation of the factors which inform decisions about dangerous limits. This detailed analysis provides the background for examination of public discourses on the dangerous limit debate, and allows a judgement to be made on the ways these public discourses differ from the findings of the primary climate research.

3.2 Defining uncertainty

Despite the increasing recognition in academia that simple, linear formulations leading from "more science" to "less uncertainty" and then to "political action" are inherently flawed, reduction of uncertainty remains a central, perhaps the central, goal of scientific research carried out in the context of environmental controversies (Sarewitz, 2004, 386; Wynne, 1991: 120). Agrawala, writing on the early stages in the development of international climate change policy, suggests that the belief in the promise of control through the scientific reduction of uncertainty is still very much adhered to in bureaucratic policy structures (1999: 44).

Researchers working within a more constructivist framework tend to argue that uncertainty is the product of the social and political context within which research is conducted (Einsiedel and Thorne, 1999; Stocking and Holstein, 1993), and is shaped significantly by institutional and

political constraints on the means by which knowledge claims are generated, contested and accepted (Brown, 2003; Shackley and Skodvin, 1998). Wynne and Jasanoff identify media, the law, regulatory agencies, advisory bodies and advocacy groups as key institutional and political factors in the process of defining uncertainty (1998: 27-28).

These institutions tend to assume (or require) that all uncertainty be quantifiable, leaving qualitative questions such as "what counts as uncertainty?" unasked (Tickner, 2003: 6; Schneider et al., 2002: 55). The quantification of uncertainty is seen in some quarters as an ideological act - providing the impression of objectivity while denying the culturally determined components of the knowledge production process (Mulkay, 1991: 8; Wynne and Jasanoff, 1998: 26; Kline, 2010: 9). The desire to turn unknowns into knowledge, and the assumption that to count as knowledge the answer must be quantitative, can be understood, at least in part, as an act of power (Backstrand and Lövbrand, 2007; Patton, 2002). In this scenario problems become defined as technical, solvable only by highly educated experts.[18]

Wynne and Jasanoff use Mackenzie's certainty trough to explore aspects of subjectivity in relation to defining uncertainty. In this model perception of uncertainty varies with distance from the point of knowledge production – perception of uncertainty is high for those closest to production of knowledge and higher still for those most alienated, with a greater degree of certainty characterising the attitude of those actors in between these two extremes (Mackenzie, 1990, cited in Wynne and Jasanoff, 1998: 13 and 30–31).

Figure 4: *Mackenzie's 'Certainty Trough', from Wynne and Jasanoff (1998)*

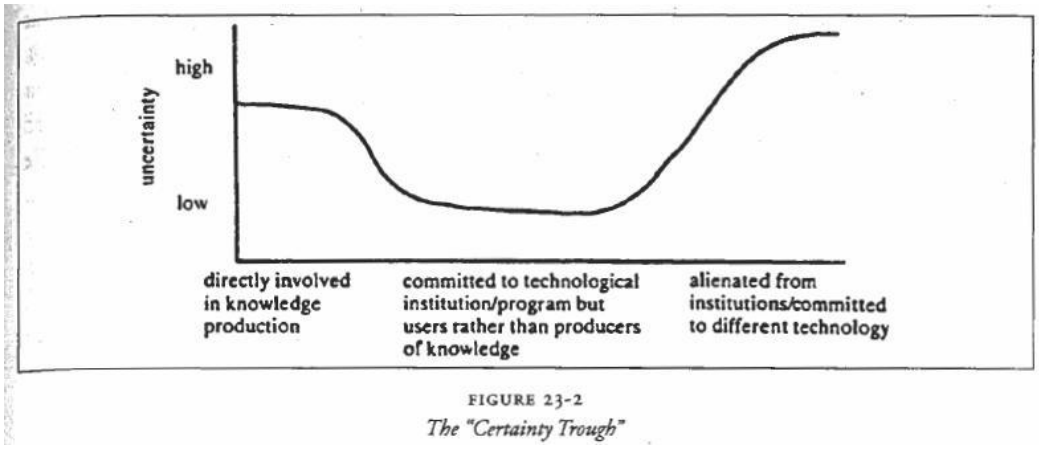


FIGURE 23-2
The "Certainty Trough"

[18] Thus, in March 2010 the Royal Statistical Society could claim an interest in the quantification of climate uncertainty to be a new phenomenon, which statisticians were best placed to resolve (Chandler, Rougier and Collins, 2010).

Socio-psychological approaches to understanding uncertainty downplay the social elements of the process, and instead argue that the creation of certainty where there is none is almost instinctual, part of our perceptual, emotional and cultural inheritance (Gigerenzer, 2002: 14).

3.2.1 Uncertainty in projections of future climate scenarios

Uncertainty in climate projections is expressed in two areas of study; climate sensitivity (how will the climate react to a doubling of atmospheric concentrations of CO_2) and understanding the 'climatological, ecological, and social impacts associated with any given level of atmospheric CO_2' (Azar and Rodhe, 1997: 1818). An editorial in the journal *Global Environmental Change*, as an introduction to a special issue on the topic of uncertainty and climate change, claimed that as of that time (2007) there had been little systematic assessment of what uncertainty means for the many dimensions of climate change analysis and action (Dessai et al., 2007: 1). Instead, treatment of uncertainty in climate science up to that time had been guilty of what Shackley and Wynne (1996: 285) term the 'condensation' of uncertainty's many meanings and complexities into 'one undifferentiated category', which assumes that these uncertainties are reducible through more measurement and the adoption of better analytical tools (1996: 285)[19]. The promise of better modelling in the future is not simply driven by policy institutions, but has been identified as a recurrent theme of the climate science discourse (Pope, 2007; Boehmer-Christiansen, 1994; Demerrit, 2001).

There is some debate about whether it is policy makers or the public who are most troubled by uncertainty in climate science. Lowe, Brown, Dessai, Doria, Hayes and Vincent (2006), and Rachlinski (2000) claim that robust policy cannot be formulated without productive public engagement, and that such engagement is impossible without first resolving the uncertainties

[19] The IPCC 2007 Synthesis report voiced the need for the IPCC to seek to quantify uncertainties, whilst recognising that those uncertainties cannot be eliminated, only reduced. (IPCC 2007, Working Group II: Impacts, Adaption and Vulnerability). An attempt was made to set up a framework for assessing uncertainties and to ensure thought processes and subjectivities were transparent and traceable for the third IPCC report of 2001 'but the problem was no-one wanted to police it' (Personal communication, September 2009). Schneider co-chaired the group assessing uncertainties in the 2007 report. Schneider et al. reported:

> An understanding has been reached between IPCC scientists and government decision makers in defining the aspects of dangerous climate change that scientists can address, as distinct from the aspects that decision makers at all scales - individuals, corporations, local governments, state governments, national governments, or international governments - have to define. One key task for scientists is to characterize the inherent uncertainty in the projections of future climate change, to try to bound the range of potential outcomes, and, if possible, to assign subjective confidence levels to various processes or outcomes (2007: 788).

The goal of the attention to uncertainties in the IPCC 2007 report is to standardise how uncertainties are characterised across the various sections of the report. This means that all uncertainties be quantified (ibid). The controversies surrounding the inclusion of apparently erroneous claims in the 2007 report that Himalayan glaciers will disappear by 2035 indicates that the framework, or its application, has not fully succeeded in achieving its aims.

and confusion surrounding climate science. Whilst policy makers are waiting for science to reduce uncertainty to such a level as to allow robust policy making (Dessai, Hulme and O'Brien, 2007: 2; Parry, Arnell, McMichael, Nicholls, Martense, Kovatsc, Livermore, Rosenzweig, Iglesiag, and Fischer, 2001: 81; Parry, Hulme and Carter, 1996: 1) the empirically under-determined modelling results are being over-interpreted both by scientists (Pearce, 2007b) and the downstream users of the findings, who may not fully understand all the uncertainties that exist (Demerrit, 2001: 322).

Other commentators claim that the extent and significance of the uncertainties are exaggerated by decision makers so as to postpone taking action which may be unpopular with the public, powerful interest groups, or both (Boykoff and Boykoff, 2004; Demerrit, 2001; Weingart, Engels and Pasengrau, 2000). Stocking and Holstein discuss how corporate and special interests have developed a wide repertoire of methods to manufacture doubt about science that threatens their interests, most recently focussing the skills learnt from tobacco lobbying to climate change (2009: 23).[20] The fear that politicians will exaggerate uncertainty to appease powerful interest groups causes scientists to downplay the uncertainties, according to Lövbrand (2004: 453).[21] As one prominent climate scientist noted 'because climate change is not just a scientific topic but also a matter of high policy, good data and thoughtful analysis may be insufficient to overcome confusion that masquerades as uncertainty caused by the clash of different interests, standards of evidence, or degrees of risk aversion/acceptance' (Moss, 2007: 5). Bazerman asserts that there is not any significant uncertainty in the climate change debate as regards the primary issue - our political elites know climate disasters are inevitable but are refusing to act (2006), a point echoed by Dessai et al., who maintain that the uncertainties are not of sufficient magnitude to prevent policy makers planning effective adaptation strategies (2010).

For researchers who argue that institutional attitudes to handling climate uncertainty are a product of the social aspects of the knowledge production process, achieving consensus in a large organization such as the IPCC is only possible by downplaying the uncertainties (Boehmer-Christiansen 1994; Biello, 2007), in order to provide policy makers with a

[20] The American Petroleum Institute (API) launched a campaign in the late 1990s designed to promote the uncertainties in climate science, and thus erode public support for emission reduction policies. The strategy was laid out in a 1998 memo from API addressed to the climate science team at Shell, titled 'Draft Global Climate Science Communication Plan'. The memo suggested that the communication plan could be deemed successful when 'average citizens "understand" (recognize) uncertainties in climate science; uncertainty becomes part of the "conventional wisdom"; when media "understands" (recognizes) uncertainties in climate science; when industry senior leadership "understands" (recognizes) uncertainties in climate science' (Union of Concerned Scientists, 1997).

[21] This accusation formed the basis of the 'climategate' controversy that arose at the time of the Copenhagen Summit at the end of 2009.

'serviceable truth' (Agrawala, 1998: 44). Weart notes that the decision of the IPCC in the 2nd Assessment Report of 1995 to stick to the same climate sensitivity range as appeared in first IPCC report was a political decision, as the authors did not want to give critics an opening to cry inconsistency. This incorporation of political concerns into the climate science is, for Weart 'a striking demonstration of how the IPCC process deliberately mingled science and politics until they could be scarcely disentangled' (2003: 173).

Rather than trying to hide uncertainties, it is claimed that scientists are happy to play along with the notion of uncertainty in climate science as significant, but reducible through more science, in order to secure funding (Bohemer-Christiansen 1994; Hulme and Dessai, 2008).[22] The notion of uncertainty as a political tool is confirmed by Lowe and Lorenzoni, whose research into expert definitions of dangerous climate change concluded that ontological assumptions about what counts as dangerous climate change originate in policy circles, and the science is then used to justify these constructions (2007: 133). Risbey proposes that science is often invoked by opinion formers to justify value choices in the face of uncertainty (2008: 27). In this sense science acts as 'a court of final appeal' (Mendelsohn, 2003: 113).

Lowe, Brown, Dessai, Franca Doria, Hayes and Vincent note that uncertainty in climate science is giving rise to mixed messages, academic controversy and political posturing (2006: 435), whilst Smith and Elliot argue that the politicisation of uncertainty is the inevitable result of using science to address environmental problems. This reliance on science to provide answers under conditions of uncertainty can actually increase the level of conflict rather than reduce it, as each party uses the uncertainty highlighted by the science to support their own views (2007: 2) a point echoed by Kahan (2010: 296).

3.2.2 What counts as uncertainty in climate science?

Another strand of the discussion about uncertainty in climate change science reflects Donald Rumsfeld's now infamous dictum that there are known unknowns and unknown unknowns. From this perspective the uncertainty surrounding climate science is so profound as to make it difficult to even know the extent of the uncertainty (Arnell, Tompkins, Tompkins and Adger, 2005: 1421). Several other observers conclude that the domain of ignorance is potentially so

[22] Hansen suggests that scientists downplay the severity of the outcomes of warming both because of their innate caution and because scientists promoting more manageable projections of change are more successful in securing funding (2008). Smithson has identified a scientific bias towards claiming that the extent of uncertainty can be defined, as institutional norms demand that science specify the ignorance for which it seeks funding to resolve (1980, 1993). Ravetz believes scientists refuse to air uncertainties in public for fear it will undermine public faith in science (2006: 79).

great and irreducible as to render climate projections virtually worthless (Weart, 2003; Allen, 2009; Wohlforth 2004; Oppenheimer, 2005; Pearce, 2007b).

Rather than condense uncertainty about climate science into a monolithic state of ignorance, attempts have been made to differentiate between various uncertainties, on the basis that some are reducible, and others not (Hulme and Newa, 2000: 203). This distinction is sometimes articulated as a need to differentiate between quantifiable and unquantifiable uncertainties, on the assumption that quantifiable uncertainties are more likely to be reducible, for example through improved modelling (Dessai, Hulme and O'Brien, 2007: 4). Thus Dessai and Hulme have drawn a distinction between uncertainties in physical and social systems (2004). Many quantifiable uncertainties, such as are to be found in physical elements of the climate system are reducible, whilst unquantifiable uncertainties, for example possible future changes in people's behaviours, are probably irreducible (ibid).

Uncertainty can be specific to the application of the science - a 'cascade' or 'explosion' of uncertainty arises when conducting climate change impact assessments for the purposes of developing national and local adaptation strategies (Corfee-Morlot and Hohne, 2003: 280). The authors use the word 'cascade' because any one stage in the analysis of the 'cause-effect' chain, from release of CO_2 through to long term impacts, must build on the uncertainties inherent in each previous stage of the analysis (ibid). Others see the uncertainty as a product of the methodological framing of climate change processes. Hawkins and Sutton identify three methodological causes of uncertainty in climate projections; natural fluctuations in the climate, differences in results from different modelling assumptions and 'scenario uncertainty' - for example, social and energy use changes which may arise in the future (2009: 1095). Woodward echoes this theme and cites decisions about which qualities should be recorded and validated, and which excluded as a key reason for uncertainties in climate projections (2003: 163). Schneider and Kuntz-Duriseti argue uncertainties arise from such factors as linguistic imprecision, statistical variation, measurement error, variability, approximation, subjective judgment, and disagreement (2002: 55). Another methodological limitation is the closed decision making process, which limits the available range of knowledge and therefore the questions asked of the data (ibid: 168). Recognition of these limitations has led to current risk assessment processes being criticised for failing to address the fact that, by definition, there will be factors of relevance that will remain outside the scope of the risk assessment. 'This is the domain of ignorance - the source of inevitable surprises, or unpredicted effects. No matter how sophisticated knowledge is, it will always be subject to some degree of ignorance' (Harremoës, Gee, MacGarvin, Stirling , Keys, Wynne, and Vaz Guedes, 2002: 4). This ignorance may be in part due to our perceptions being determined by our pre-existing knowledge and

beliefs (Shrader-Frechette, 1991: 41). Shrader-Frechette identifies methodological bias, which shapes decisions about what data to collect and what to ignore, as a key variable in researching complex problems (1991: 41). Schneider and Kuntz-Duriseti provide a telling instance of just such a lapse resulting from unacknowledged methodological values. The thinning of the ozone layer over the South Pole in the late 1970s went undetected for years. The satellite instrumentation did not fail; rather, the computer programs written to analyze the vast volumes of satellite data were instructed to reject measurements that diverged sharply from expected normal conditions. The rejected values were called to no one's attention, and it was a manual inspection of the data which led to the discovery of the thinning of the ozone layer (2002: 53).

3.2.3 Risk and uncertainty in climate projections

Despite widespread understanding in the social sciences that uncertainty is subjective, the response to uncertainty favoured by policy makers is to seek a single measure of risk. This is usually done through the academic discipline of risk, which reduces the plurality of attitudes to risk down to a single, quantifiable metric, normally in the form of a cost-benefit analysis. Mol and Spaargaren divide discussion of risk between two distinct typologies, one understanding risk in a purely physical sense, the other defining risk as socially constructed (1993: 432). Rayner claims the formal study of risk can be conceptualised along a continuum, with at one end realist or, at the very extreme 'naive–realist' accounts (1987: 5) and at the other extreme, strongly constructivist descriptions. It is the realist accounts which dominate discussion of climate change risk, most notably the Stern Review of 2006. Strongly constructivist accounts, sometimes also described as a cultural or anthropological approach to the study of risk, have been most famously espoused by Douglas and Wildavsky (1982), who examined how cultural norms influence attitudes to risk. Slovic, still in the constructivist school, has proposed a cognitive approach which differentiates between lay and expert definitions of risk (1987). I provide an overview of these debates in order to highlight the extent to which the realist approaches to understanding climate risk extend into the debate about defining a dangerous limit.

Shrader–Frechette summaries the science of risk management strategy as a three stage process involving a) the identification of the risk b) estimation of extent and level of potential harm and c) evaluation of the acceptability of that harm relative to other hazards (1991: 5). Eden divides risk analysis into two phases, assessment and management. In this schema, assessment is understood as a pursuit best undertaken by scientists, whereas management

should be a separate function that exists as part of the policy process. Assessment is normally a statistical exercise intended to model the probabilities of a risk arising. Management requires the use of a cost-benefit analysis to guide responses to the risk (Eden, 2004: 346). Where there is more uncertainty than data, use of these tools becomes more subjective, and thus more contentious and problematic (Waterstone, 1991: 17).

3.2.3.1 Probabilities and climate projections

Risk assessment seeks to accommodate uncertainty through statistical modelling (Tickner, 2003: 6). The desired outcome of such modelling is a credible, probabilistic assessment of the likelihood of a particular event or events arising (ibid) and is the approach to climate prediction employed in IPCC reports. From this perspective danger is understood as a combination of high stakes and unfavourable odds (Malnes, 2008: 661). Probabilistic modelling divides between subjective and empirical methodologies. The empirical methodologies apply where the range of outcomes are determined by the intrinsic properties of the system, whereas subjective probabilities are shaped by the beliefs of the modeller (Swart, Ha Duong and Bernstein, 2007: 9).

With subjective probabilities, 'uncertainty can always be turned into risk' (Gigerenzer, 2002: 27). All that is required is for all possible outcomes to be attributed a value which totals one. Probabilities modelled solely on empirical observation are comprised of two separate approaches - propensities and frequencies. Propensities describe outcomes constrained by physical properties - when rolling a dice the chance of getting a three are defined by the properties of the dice, i.e. there is a one in six chance of throwing a three. Frequency probabilities (or frequency distributions) are based on a large number of observations, i.e. the uncertainty about the outcome of rolling the dice would be determined empirically through rolling the dice many times (Gigerenzer, 2002: 28). Projections of climate change impacts are not bounded by physical properties of the system in the same way as illustrated by the dice example.[23] Therefore it is necessary for climate projections to employ probabilistic assessments and frequency distributions, techniques which use data alongside subjective judgements.

[23] The physical aspects of climate change are bounded by the physical properties of the system, but those properties are, at a global scale, too complex to be fully addressed in models. In addition, various subjective assumptions have to be made about how social systems will change and influence or respond to the climate system. Hulme and Newa report that a variety of emissions scenarios are used in IPCC reports to reflect a range of possible future emission scenarios. Developing these emission scenarios requires the modellers to make subjective judgements in defining the storylines, about the structure of their models, and about what the parameter values of these models should be. The resultant emissions scenarios therefore contain an in-built subjectivity that precludes low-probability (in the opinion of the modellers) emissions futures (2000: 203).

Belief about the likelihood of any particular event arising is, from a realist perspective, the product of a rational, consistent thought process which is directly translatable into a probability statement (Baer, 2005: 56-58). Thus realist approaches to risk assessment are predicated on the assumption that subjective judgements can be rationally incorporated into science through adequate probabilistic calculations (Kline, 2010: 4; Gigerenzer, 2002: 22; Nowotny, Scott and Gibbons, 2001: 34; Cooke, 1991: 18). This hybrid of data and opinion is described as Bayesian probability. Employment of Bayesian techniques is viewed as necessary when dealing with complex problems permeated by uncertainty, as the alternative is to say 'we know nothing at all' (Hulme, 2009: 73). The reliability of a statement drawn from the Bayesian probabilities of an event occurring is dependent on the qualifications of the person (or more often persons) making the statement (Hulme, 2009: 85). Bayesian paradigms derive their legitimacy from the assumption that the opinions are generated by rational and consistent decision making and are predicated on the assumption that utility maximisation should be the decision rule in situations of uncertainty (Shrader-Frechette, 1991: 96). This form of scenario modelling has been the dominant frame for discussion of climate sensitivity and adaptive and mitigation strategies. It has not, and cannot be directly used for deciding on a dangerous limit, which is a purely normative decision. Bayesian assessments of future climate change scenarios provide a choice of outcomes which policy makers can use to help decide what will be defined as a limit to climate change. Deciding on what outcome to aim for is not a scientific process, but a value choice, albeit one which is potentially[24] informed by probabilistic assessments derived from scientific modelling.

Another subjective element in probabilistic modelling is expressed in decisions in the degree of probability selected as appropriate to the modelling process. Dessai et al., (2010) identify a distinction between precision and accuracy in probabilistic assessments. A precise assessment provides a narrow distribution curve of possible outcomes, but could be wrong, in failing to capture low probability events. An accurate probabilistic assessment will be less precise, but is

[24] 'Potentially' because there is no quantification of the weight policy makers give to climate science compared to other considerations, such as the need for continued economic growth. However, some pronouncements from policy makers give an indication of how the need to avoid dangerous climate change measures up against other aspirations. For example the UK's then Prime Minister Tony Blair wrote in 2005 that 'The truth is no country is going to cut its growth or consumption substantially in the light of a long-term environmental problem' (The Daily Telegraph, 25/09/2005). Oliver James, writing in The Guardian in 2005, claimed 'I have talked to two of Blair's key advisers at some length, and the fact is the treasury refuses to countenance any ecological legislation that threatens affluence' (James, 2005). This prioritising of economic norms is also apparent amongst US political elites. Quoting the White House spokesperson from 2001, Hamilton summarises US attitudes to environmental policy thus 'The President believes that it's an American way of life, and that it should be the goal of policy-makers to protect [it]. The American way of life is a blessed one . The President also believes that the American people's use of energy is a reflection of the strength of our economy, of the way of life that the American people have come to enjoy' (Hamilton, 2007). Jackson recounts a meeting about his 'Redefining Prosperity' project where a UK treasury official accused him of wanting to 'go back and live in caves' (2008: 42).

more likely to capture the 'true value' (albeit alongside a range of incorrect values). The role of rationality in Bayesian analysis has been questioned by Baer who, in discussing the study of climate sensitivity, argues that faced with huge uncertainties 'what you choose to act as if you believe is fundamentally an ethical choice' (2005: 14).

Budescu, Broomell and Por highlight the uncertainty that arises when trying to turn these probabilistic models into verbal terms which can be understood by a wide range of actors. Thus, attempts by IPCC lead authors to use a set of seven terms to describe the probabilities (from virtually certain [>99% probability], down to exceptionally unlikely [<1%]), have failed to overcome the imprecision of the terms, with the result that the meaning of the words are interpreted differently by different audiences (2009: 299).

3.2.3.2 Probabilities and climate sensitivity

Probabilistic assessments have been key in trying to establish the relationship between changes in atmospheric concentrations of CO_2 and warming of the earth's surface. The relationship between atmospheric concentrations of CO_2 and changes in the climate is described as climate sensitivity. Climate sensitivity is a key parameter of climate modelling and climate policy, and is a measure surrounded by significant uncertainty (Ackerman, DeCaino, Howarth and Sheeran, 2009: 297; WBGU, 2003: 9; Baer, 2006: 80). Such is this uncertainty that some researchers have sought other metrics as a proxy for dangerous climate change (for example the WBGU [1995] uses parameters based on previous climatic regimes, rather than try to relate specific climatic changes to particular atmospheric concentrations of CO_2).

Attempts to calculate climate sensitivity have focussed on modelling what happens when atmospheric concentrations of CO_2 are doubled. In fact, so ubiquitous has the assumption of a doubling of carbon dioxide been in these calculations that the term 'climate sensitivity' does not refer to calculations of warming from a range of different increases in CO_2, but refers only to the consequences of a doubling of CO_2. Atmospheric concentrations of CO_2 are measured in parts per million (ppm).[25] Pre-industrial concentrations of CO_2 are estimated to have been

[25] Carbon dioxide is often described as the main greenhouse gas, it being the most prevalent greenhouse gas in the atmosphere. There is considerable debate over whether in fact ppm measurements should include other greenhouse gases as well, such as methane. Measures which include these other gases are described as CO_2 – equivalent. When the latter measure is used the climate sensitivity is lowered (i.e. one would expect two to three degrees of warming from 400ppm rather than 450ppm). The environmental campaigner George Monbiot has examined this issue, arguing that the CO_2 – equivalent measure is seldom used for reasons of political expediency (Monbiot, 2006).

in the region of 280ppm (IPCC, 2007), and so climate sensitivity is modelled on the premise of atmospheric concentrations of CO_2 of 550ppm. Probability distributions from multiple model simulations of a 550ppm scenario cluster around temperature increases in the range of between 2^0C and 4.5^0C, with a best estimate of three degrees (IPCC, 2007: 92). Though probabilistic assessments can only provide a range of potential climate sensitivity outcomes, policy making requires a single figure, not least because projected impacts from a 2^0c - 4.5^0c range of warming vary drastically.[26] The range of potential warming scenarios, and consequent impacts, suggested by the sensitivity assessments has opened up space for challenges to the climate sensitivity target. Rather than a target of a doubling of CO_2, it has been argued that atmospheric concentrations of CO_2 should not rise above 350ppm (Azar and Rhode, 1997) 400 ppm (Blair et al., 2005) and 450 ppm (Barker, 2008), whilst the original Stern Review backed the 550ppm target (Stern, 2006). None of these ppm targets offer guarantees of staying below two degrees of warming, but instead come with varying probability statements about the likelihood that these concentrations will keep warming below two degrees, some of which have confidence intervals of 21- 69% (see Hurd and Kerr 2007: 4 for a summary of the various confidence intervals).[27]

Harvey (2007a, 2007b; but see also Ramanathan and Feng, 2008) has used calculations of climate sensitivity to draw a distinction between dangerous anthropogenic interference (DAI) with the climate and the danger of the impacts themselves. The UNFCCC required concentrations to be stabilised at a level that avoided DAI. Harvey argues instead the discourse has, erroneously, focused on dangerous impacts. Harvey defines DAI as:

> a set of increases in greenhouse gas concentrations that has a non-negligible possibility of provoking changes in climate that in turn have a non-negligible possibility of causing unacceptable harm, including harm to one or more of ecosystems, food production systems, and sustainable socio-economic systems, whereas dangerous climate change is a change of climate that has actually occurred or is assumed to occur and that has a non-negligible possibility of causing unacceptable harm.
>
> 2007a: 1

[26] See Smith et al. (2009) for an update of the impacts associated with various warming scenarios.

[27] It has been claimed that the use of confidence intervals in climate modelling is largely informal, and exists to accommodate the varying results of modelling experiments, thus overcoming any disagreements about the results across the various epistemic communities who use this knowledge for planning and modelling exercises (van der Sluijs et al., 1998).

In other words, the dangerous limit has already been passed, because changes already made to the chemistry of the climate could cause dangerous impacts. On this basis Harvey concludes that current concentrations of CO_2 are already high enough to constitute dangerous interference with the atmosphere.

3.3 Cost benefit analysis and dangerous climate change

In modern societies political institutions generally make decisions about risk within the framework of cost-benefit analysis (CBA), which seeks to weigh the financial costs of avoiding the modelled risk scenario against the benefits (either economic and/or social) of avoiding the anticipated harm(s). As regards climate change mitigation policies, this means if it is cheaper to prevent emission of a tonne of CO_2 than it is to repair the damage caused by the release of the CO_2, then prevention is the appropriate course of action (Hulme, 2009: 120; Schneider and Kuntz-Duriseti, 2002: 55). However, this simple metric ignores the fact that not every tonne of CO_2 has the same climate impacts. A tonne of CO_2 released into an atmosphere which already has an excess of CO_2 is likely more damaging than a tonne of CO_2 released into a pristine atmosphere. For this reason some have argued that policy should take account of the cumulative effect of emissions (for example Allen, Frame, Huntingford, Jones, Lowe, Meinshausen and Meinshausen, 2009). If one thus imagines the budget in terms of a total weight of CO_2 in the atmosphere, the nearer to that total budget one gets the more value one may attribute to each individual tonne of CO_2 released.

Kimble and Tawney argue that the application of cost-benefit analyses to climate change policy is born of the recognition that there is no line separating safe from dangerous climate change. Instead the cost-benefit analysis seeks to define what is an acceptable level of warming, acceptable in this sense having a purely economic meaning (2009: 25). Cost-benefit analyses therefore derive their legitimacy from the assumption that some amount of damage is reasonable, affordable, even efficient compared to the cost of entirely stopping the pollution (ibid). The CBA approach derives its validity from the principle that there is an optimal balance between warming and economic growth. Such an optimum is intended to provide the maximum economic growth at the minimum of climate change impacts. The Stern Review of 2006, the most well publicised attempt to define climate risk through economics, argued that this optimum equates to an atmospheric concentration of CO_2 of between 538ppm-750ppm, or a warming range of 2.33^0c - 3.9^0c (Stern, 2006: 298).

Cost benefit analyses of climate risk have been criticized for over-simplifying complex processes, and doing so within an ostensibly scientific and economic framework which masks a range of normative assumptions (Schneider and Kuntz-Duriseti, 2002; Baer, 2006; Baker, 2008; Funcowitz and Ravetz, 1993; Nelson, 2007; Hawkins, Holmes and Helweg-Larsen, 2008). According to these critiques, deciding what is a cost and what a benefit is not reducible to the scientific balancing of neutral numerical values, but is instead a distinctly social and cultural process (Johnson and Covello, 1987: viii; Barker, 2008: 13). Therefore CBA can only be used to inform climate change policy by over-simplifying the social and physical dimensions of the problem. For example, CBA of climate change tends to assume climate change will be linear, all impacts can be monetized, prices can be agreed and that the winners will compensate the losers (Dowlatabadi, 1999: 297-298).

Kimble and Tawney provide an example of this over-simplification by examining the way CBA treats high-impact low-probability climate events. CBA of climate risks only works by trimming off the 5% at the end of the probability distribution tail for climate sensitivity models. The IPCC Working Group 1 assessment of 2007, on the basis of a comparison of different probability distribution functions, shows a 5% chance of 6 degrees centigrade or more of warming at 550ppm. Kimble and Tawney argue a CBA could only have come up with a recommendation of 550ppm by ignoring this fat tail[28], as much existing environmental law would not deem such a risk as acceptable (2009: 28). Ignoring the far end of the probability distribution is an arbitrary decision which, according to at least one economist, undermines the validity of the analysis (Weitzman, 2009).

Another area of subjectivity in CBA is the choice of discount rate, which is essentially an ethical choice about the 'moral weight to be granted to people who are not yet alive' (Nelson, 2007: 2). Hulme, in discussing the economics of climate change, sees the use of the social discount rate as an important element of CBA, especially when dealing with a process whose impacts may be felt for many years into the future (2009: 120). The social discount rate, in balancing the welfare of current generations against that of future generations, in essence takes as read that future generations are willing to go along with current decisions to forgo their environmental quality for increases in material wealth (Schneider et al., 2002: 61).

Discount calculations measure the worth of today's dollar against its projected future value, say five years hence (though there is no fixed time period for discount rate calculations). One dollar today is worth more now than a dollar five years from now because today's dollar can be invested and a return gained. The agreed difference in value between now and then is the

[28] A 5% probability tail is here described as a fat tail compared to a 1% 'thin' probability tail.

discount rate. A low discount rate assumes that a dollar today is not of much more value than one dollar five years hence. A high discount rate would afford greater value to today's dollar. In the latter scenario it would only be necessary to put aside, for example, five dollars today to offset one hundred dollars worth of climate change damage fifty years from now. A low discount rate would assume a far greater investment today to pay for the one hundred dollars worth of future climate damage. The choice of which discount rate to use is the most important decision for anyone making long distance plans (Dyson, 2008: 44). Identification of an appropriate discount rate features prominently in discussion of climate change mitigation strategies, most notably Stern (2006), Tol (2007) and Nordhaus (2008). Different economists have different views about the correct discount rate to use when formulating appropriate levels of emission cuts is. Defining a discount rate must take account of issues such as future opportunities to change course, assumptions about the wealth of future generations, the expense of present and future emissions cuts, depending on assumptions about innovation, capital stock turnover, and other aspects of the shift to a low-carbon economy (Kimble and Tawney, 2009: 26). The discount rates employed in the Stern Review are used to support the conclusion that the 550ppm target can be accomplished at a cost of about 1% of world GNP, compared to welfare losses equivalent to 5% to 20% of GNP under "business as usual" climate change (Stern, 2006: vii).[29] Nordhaus (2008) has argued that Stern uses too low a discount rate, and argues for a 4% discount rate rather than the near zero rate argued for by Stern. Under Nordhaus' calculations there is little economic argument for reducing economic growth – the cost of climate change damage would be less than the cost of slowing economic growth (Dyson, 2008: 44).

Researchers have sought to respond to these subjectivities in different ways. In some quarters CBA is considered to remain a valid tool for determining policy options, as long as the role of embedded assumptions, value judgments, and any aggregations performed in the assessment are made clear (Schneider, 2007: 61; Schneider and Kuntz-Duriseti, 2002: 55; Shrader-Frechette, 1991: 170–176). Another response has been to try to develop more sophisticated frameworks to guide decision making. Integrated Assessment Models (IAMs) are positivist frameworks which seek to amalgamate economic and physical factors into one model in order to provide more meaningful information to decision makers (Davis, Moss and Pahl-Wostl, 2001: 27). It is felt, by the advocates of IAMs, that the interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines provides an

[29] Stern's cost-benefit analysis rules out staying under two degrees of warming as economically unjustified, and his calculations are predicated on the assumption of mitigating climate change to ensure warming stays below three degrees centigrade. Stern has, in a series of recent interviews, recanted on this position, arguing that instead of aiming for a 550ppm target as laid out in his 2006 report, the safe target is in fact 330ppm (Stern, 2009).

avenue for increased understanding of the cause and effect chains of global environmental change (Rotmans and van Asslet, 2001: 327). However, it has been argued that IAMs still require the inclusion of subjective judgements into where there is uncertainty, rely on contested discount rates for the economic elements of the model, and involve questionable assumptions about the economic value of human life and ecosystems (Ackerman et al., 2009). Yohe, whilst acknowledging these deficiencies, says IAMs cannot be abandoned, but must be improved as it is the only model which speaks the language policy makers recognise (2009: 325).

3.3.1 Alternatives to cost benefit analysis

Other models and frameworks which seek to offer an alternative to CBAs and IAMs are more explicit about the role of values in the decision making process around risk and global change. These approaches call for greater public involvement in decision making under uncertainty, thus allowing citizens to become both critics and creators in the knowledge production process (Rayner, 1987: 8). Cash, Clark, Alcock, Dickson, Eckley, Guston, Jaeger and Mitchell argue that some form of extended peer-review process is essential not only in order to find a solution to environmental problems, but to legitimate current institutions and social relations in the face of these issues, thus ensuring environmental science continues to be seen as 'credible, salient and legitimate' (2003: 8086). This is a concern shared by Lövbrand, who calls for an explicit recognition of the social limits to climate science 'to ensure rather than undermine continued scientific authority in the international climate regime' (2004: 449). 'Participatory integrated assessment' (Rotmans and Dowlatabadi, 1998; Kasemir, van Asslet, Durrenberger and Jaeger, 1999; Tansey, Carmichael, van Wynsberghe and Robinson, 2002) is one example of an attempt to include widely divergent attitudes to risk into a model which takes account the vast complexity and inter-linkages between different parts of issues such as dangerous climate change, and attempts to address the problem by combining insights from different parts of natural and social sciences such as environmental chemistry, economics and cultural theory (Dessai et al., 2004: 20).

The revealed market preference analysis, as a form of internal risk assessment is an attempt to understand how much value an individual puts on their environment. Data from relevant markets or choices is used to distinguish internal concepts of dangerous from non-dangerous risk. For example, one can ask what level of economic benefits would need to be promised to an individual before she would be willing to accept the building of a nuclear power station in her county? Sagoff questions the usefulness of a revealed market preference analysis because

the decisions we make as individual consumers are not the same as those we make as citizens (1988: 52-55). Consequently, one may want the job offered by the building of a nuclear power plant because the money on offer is attractive, or one is unemployed, whilst at the same time not wanting the power plant in your neighbourhood because, as a parent, you are worried about your children's safety (ibid). Dessai et al., express concern about the validity of participatory analyses of climate change risk on the basis that the public may not have sufficient knowledge about climate change risk to be able to make a well-informed, and thus rational, judgement (2004).

Whilst CBA and the above derivatives have as their goal an optimal response, which does just enough and no more, others have argued for a more robust response, robust in this sense meaning a willingness to risk doing more/spending more than may be necessary, in order to guarantee the avoidance of danger. An important difference between a robust and an optimal response, at least as regards the issues around uncertainty described above, is that an optimal response requires more accurate projections than those needed for a robust response (Dessai et al., 2010)[30] because a robust response prioritises safety over cost saving.

3.3.2 The precautionary principle

The precautionary principle is the dominant policy incarnation of the desire for a robust response to 'high uncertainty/high stakes' environmental problems (Ravetz 2006a: 18). In brief, the precautionary principle asserts that uncertainty should not be an excuse for inaction, and advocates the use of cautionary subjective judgement in the decision making process. Application of the precautionary principle means that under conditions of uncertainty decisions must rely as much on subjective judgement as objective scientific evidence (Roberts, 2004: 12). These subjective judgements should favour false positive judgments (or Type I errors), over false negative judgements (Type II errors). Thus a false positive judgement means one errs on the side of caution - better a false alarm than failing to take the necessary action. There are a large number of treaties which have sought to formalise the idea of precaution in environmental decision making, including the UNFCCC. The precautionary principle is also deemed to be the principle which supported the EU's declaration of the two degree limit (Shaw, 2010).

[30] For example, this statement from the Meteorological Office 'It is … vital that more detailed regional climate change predictions are made available both in the UK and internationally so that cost-effective adaptation and appropriate mitigation action can be planned' (Pope, 2007).

However, application of the precautionary principle has been found wanting, it being argued that effective use of the principle has been sacrificed in the name of the continuing demand for scientific certainty and the protection of vested interests and political expediency (Quiano, 2003: 21; Raino, 2008: 663). An example of this failing is provided by Pettenger, who notes that the Dutch have been key drivers in pushing forward the EU climate change policy and the precautionary principle has been prevalent from the beginning in Dutch documents dealing with climate change, yet annual Dutch carbon-dioxide emissions rose from 210.3 million tonnes in 1990 to 216.9 million tonnes in 2000 (Pettenger, 2007: 61). Shaw (2010) argues that despite claims that climate change is an ideal case for the application of the precautionary principle the two degree target is far from precautionary, given the projected species loss and climate impacts expected to arise from two degrees of warming. Harremoës et al., in an extensive review of institutional responses to a range of different risks over the course of the 19th and 20th century 'sought but could not elicit examples of false positives, where precautionary action was taken that later proved unnecessary' (2002: 7), indicating that the principle is seldom applied in a precautionary sense. Conversely, some commentators critique the application of the precautionary principle to climate change policy as assuming all the risk arises from not taking action, whilst failing to account for the economic risks that arise from being over cautious, for example as faced by those employed in the coal and oil industries, who may lose their jobs as a consequence of policies designed to meet climate targets (Tol, 2007: 428). Advocates of the precautionary principle are sometimes regarded as being unrealistic in their desire for a world free of all risk (Kinga and Mori, 2007) arguing for policy responses which constitute 'a real barrier to progress' (Pollack, 2003: 6).

3.4 Comparing public and expert attitudes to risk

Experts and other elite actors are described as being less risk averse than the lay audience either by virtue of being blind to the risks that others see (Evernden, 1992: 6) or else because of a perception of society and nature as robust rather than fragile (Hulme, 2009: 189). Kaiser argues that the assessments of scientists and economists put a much larger value on maintenance of certain socio-economic processes than protecting the environment (2003: 48). Christoforou (2003) believes that lay perception of risk differs from experts because the former is based on a broader set of concerns, which should be accounted for by the democratically elected and accountable institutions of the state, a view also held by Wynne and Jasanoff (1998: 40). Separately, Wynne has commented that public concerns about the risks generated by scientific activity and new technology are:

> Not predominantly concerns about being illegitimately disqualified and excluded from expert debate and decision, on a propositional knowledge-question such as "what are the risks"? but are more about the presumptive hegemonic imposition of what the salient concerns, thus salient knowledge-questions, thus salient knowledges, are recognized to be in the first place, as the public frame of meaning of the issue at stake. This normally involves a reduction of the complex multidimensional questions involved in assessing technological-social innovations, to ones of scientific risk.
>
> Wynne, 2008: 22

In a similar vein, O'Brien worries that the very definition of environmental issues like climate change as a scientific problem excludes the public from engaging with the weighing of the risks posed by such phenomenon: 'The question "is there enough credible evidence that a significant harm is significantly likely" excludes most of the public' (2003: 285). Schudson notes the widespread concern that expertise denies the possibility of equality promised by democracy; 'The expert always turns out to be on someone's side, and not necessarily ours' (2006: 495). This divide in attitude to risk between the public and experts has been described as an issue of trust; both public trust of science, and scientists' trust of the public (Durant, 2008: 8). Ekberg claims social theories of risk are inseparable from theories of trust and that risk and trust are in inverse proportion to each other - 'In an environment of high trust risk is low, and in an environment of high risk, trust is low' (2007: 356).

Expert definitions of risk rely on "external" definitions of danger. External definitions are usually narrowly based on risk analyses and assessments of system characteristics of the physical or social world (Lowe and Lorenzoni, 2007: 132) interpreted through just two dimensions – probabilities and severity of consequences (Leiserowitz, 2005: 1434). By contrast public, or internal, definitions of risk are much more complex and multidimensional, and involve consideration of issues such as justice, morality, trust and responsibility (Slovic, 1987; Wynne and Jasanoff, 1998; Lowe and Lorenzoni, 2007). Additionally, public sensitivities to risk vary according to the type of risk, with greater adversity to artificial over natural risk, imposed over voluntary risk, the degree of control, perceived fairness and familiarity of the risk situation (Waterstone, 1991: 57; Shrader-Frechette, 1991: 5).[31] Others have identified the

[31] Lowe and Lorenzoni discuss a German study which found that climate change was considered as caused by individuals through their own volition and therefore a risk taken voluntarily (18% of respondents) while 49% of

scale of the risk as an important determinant of attitudes, looking at risks which range in scale from localised issues, or 'situated risks' (Hulme, 2009: 200) such as land contamination from waste disposal (Spaargen and Mol, 1993) through to global issues such as ozone depletion (Schneider et al., 2002), radiation releases (Commoner, 1997) and climate change (Hulme, 2009; Oppenheimer, 2005). Ekberg notes that Giddens and Beck also make reference to psychological aspects of risk, as arise from the alienation and fragmentation of society under modernity (2007: 346). This social divide between internal and external definitions of risk shapes, and in turn is shaped by the communication of risk which Wardman identifies as purely a top down discourse which seeks to legitimate modernity, often promoting the upside of technological solutions and exaggerating the downsides of forgoing those solutions (2008: 1620).[32] Hulme has argued that current constructions of climate change risk, such as the two degree dangerous limit, are an attempt to merge physical and cultural determinants of risk into one single metric, and it is this misconception of climate risk that lies at the heart of the failure to develop an effective response (2008: 6).

3.5 Defining a normal climate

The target based management of climate change that I am discussing in my thesis requires a definition of 'normal' climate (Hulme and Dessai, 2008: 5). This is predominantly the 'pre-industrial average', identified by the WBGU as equating to the Holocene, a period of benign climatic stability stretching back to approximately 12,000 BCE and which enabled the development of human civilization (1997: 13). The pre-industrial average of the past 10,000 years is simplified in EU communiqués to a pre-industrial baseline of 1750 (Bierbaum et al., 2007: ix). However, the choice of baseline period has varied markedly, including the ranges 1931 to 1960, 1951 to 1980, and 1961 to 1990 (Hulme and Dessai, 2008). In the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, projections of future warming are based on a baseline of 1990 temperatures (the mid-point of 1980-1999), to align with the baseline for emission cuts in the Kyoto Protocol. The 1990 baseline is 0.5 degrees warmer than the pre-industrial, whilst the global-average surface temperature is now about 0.8°C above its level in 1750 (Bierbaum et al., 2007: v). So the IPCC's projected increase for the twenty first century of 1.1–6.4 degrees Celsius above 1980–99 levels would be about 1.6–6.9

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respondents indicated they considered climate change a risk taken partly voluntarily. Only 33% felt it was imposed by external forces, therefore an enforced risk (2005: 10-11).

[32] An example of this discourse can be found in a television documentary called 'What the Green Movement got Wrong' in which apparently radical greens recant their previous opposition to technological solutions to climate change, and now embrace developments such as GM foods and nuclear power (Channel 4, Broadcast 4th November 2010).

degrees Celsius above preindustrial level (Hare, 2009: 1). Thus there is no fixed idea of what counts as a 'normal' climate against which to assess the likely severity of changes. This disputation applies also to the definition of climate, which was 'arbitrarily and rather weakly agreed as a 30 year weather pattern in 1935 following more than fifty years of negotiation and dispute' (Hulme and Dessai, 2008: 6). The belief in the idea of a normal climate finds expression in the desire to stabilise the climate. This idea of stability is of particular appeal to policy actors, who find their ability to plan and control undermined by the impacts of climate change, and thus understand a stable climate as a 'public good' (Hulme and Dessai, 2008: 22).

Sometimes "stabilisation" of atmospheric concentrations of greenhouse gases is offered as a proxy for a stable climate (for example UNFCCC Article 2, 1992) but, as Moss has shown, exactly what is meant by stabilisation of greenhouse gases is unclear, and in any case stabilising the level of greenhouses gases will not stabilise the climate as increased levels of CO_2 will continue to change the climate for years to come (1995: 60). In one instance, the stability provided by effective mitigation is deemed political and economic, rather than predominantly climatic; 'only by mitigating the effects of climate change and finding new, achievable ways to adapt to them can the world find stability and prosperity' (Bierbaum et al., 2007: v).

A climate that moves away from a normal state is feared to be more or less dangerous, depending on a range of statistical, cultural and physical factors. The academic and scientific literature offers three approaches to the definition of dangerous climate change. The realist approach defines dangerous in terms of physical impacts, for example on ecosystems, glaciers or precipitation patterns. A second approach highlights the role of values and culture in defining dangerous change[33]. Thirdly, some authors seek a synthesis between cultural and physical definitions of danger. I examine this literature to illustrate what approach has had most influence on defining a dangerous limit. My theory assumes that the two degree limit is a concept which is an expression of elite values which has been placed on top of the physical science without having any substantive relationship to that science. The idea of the two degree limit as an economically acceptable target has been present in the literature for thirty years. The science has proceeded over that thirty year period alongside the economically derived two degree target, but without actually impacting on, or providing evidence for, the legitimacy of the two degree limit.

3.6 Physical definitions of dangerous climate change

[33] A more detailed treatment of constructivist approaches to risk is located in the theoretical framework chapter.

The biophysical perspective is by far the dominant approach to assessing vulnerability to climate change (McLaughlin and Dietz, 2008). This approach is primarily concerned with large scale biophysical impacts (WBGU: 1995, 1997, 2003; Jaeger and Jaeger, 2010; Tol, 2007; Oppenheimer and Petsonk, 2005). This fixation on large scale biophysical impacts allows researchers and policy makers the chance to avoid the complications of a more qualitative account of what dangerous climate change might be (Oppenheimer, 2005). These biophysical impacts are commonly defined in terms of 'thresholds', a critical level of change beyond which one can expect significant impacts (Parry et al., 1996: 2; Schneider, 2001: 18). Defining a dangerous threshold in terms of impacts has been challenged by authors arguing that the real tipping point is the crossing of a threshold in atmospheric concentrations of CO_2 sufficient to cause these changes sometime in the future. These tipping points have already been reached (Harvey 2007a, 2007b; Pearce, 2007b; Ekman, Rockström and Wijkman, 2008) or soon will be (Hansen, 2005; Hansen et al., 2008).[34,35]

Researchers focusing on thresholds in terms of physical impacts identify several types of threshold, though these can be condensed into two categories. The first category describes the crossing of thresholds which results from smooth change. Where on this path the decision is made to stop is a value based choice. Other researchers fear a rapid, sometimes imminent, crossing of profound thresholds which threaten such large-scale impacts as to be universally considered dangerous (Lowe and Lorenzoni, 2007: 8; Patwardhan, Schneider and Semenov, 2003: 4). The distinction between smooth and rapid crossing of thresholds reflects the widespread assumption that the speed of change is another important determinant of danger (Lowe and Lorenzoni, 2007; Leisorowitz, 2006; WBGU: 1995, 1997, 2003; Oppenheimer, 2005; IPCC, WGII 2007; Parry et al., 2001).

The large scale physical discontinuities identified as defining dangerous climate change are generally in the form of ice sheet disintegration and attendant sea level rise (Oppenheimer, 2005; Risbey, 2007; Hansen, Sato, Kharecha, Beerling, Berner, Masson-Delmotte, Pagani, Chos, Raymo and Royer, 2007; Hare, 2009), Amazon rain forest die back (Rockström and Wijkman, 2008: 21), coral reef bleaching (Blair et al., 2005), agricultural stress (IPCC 2001, 2007; Richardson, Steffen, Schellenhuber, Alcamo, Barker, Kammen, Leemans, Liverman, Munasinghe, Osman-Elasha, Stern and Waever, 2009; International Climate Change Taskforce, 2005) or other forms of ecosystem collapse (IPCC 2001, 2007; Rockström and Wijkman 2008;

[34] See Appendix 2 for a summary of physical impacts and assumed temperature ranges for those impacts.
[35] Though Lowe and Lorenzoni identify inconsistent approaches to the use of these terms in the academic literature (2005: 35).

Stern, 2006). It is argued that the consequences of such changes are so widespread and so negative as to be undeniably dangerous. Many of the analyses of dangerous physical climate change impacts, both in the academic literature but also in other public texts, take their lead from the various IPCC Assessment reports (1990, 1995, 2001, 2007). Governments have asked the IPCC to offer expert judgments on what might happen (Working Group I), what if it happened (Working Group II), and, therefore, what might be done to deal with the situation (Working Group III). The IPCC use a range of key vulnerabilities in their assessments, including magnitude, timing, persistence, potential for adaptation and importance of the system (Schneider, 2007: 60). In order to account for these disparate measures, and provide a warming range which covers them all, the IPCC calculates that the preponderance of these vulnerabilities are estimated to intensify somewhere between 0.8^{o}C and 3.3^{o}C above current temperatures (or 1.5 - 4.6^{0}C above pre-industrial).

Chapter 19 of the Working Group II report (2001) identified five "reasons for concern" that could be used to 'aid readers in making their own determination about what is "dangerous" climate change' (Smith, Schellenhuber, Mirca, McCarthy, White, Canziani, Leary, and Dokken, 2001: 915). The IPCC claims that natural systems are especially vulnerable to climate change impacts because of limited adaptive capacity (Parry et al., 2007). The 'Reasons for Concern' diagram (more colloquially known as the 'burning embers' diagram) lists different forms of physical impacts - risk to unique and threatened systems, risk of extreme weather events, distribution of impacts, aggregate impacts, and risk of large scale discontinuities (Smith et al., 2001, See Appendix 2). The 'Reasons for Concern' framework is drawn from the IPCC's analysis of when such impacts are likely to be felt through a series of scenarios projecting future trajectories of emission levels and warming. Known as SRES for short, these scenarios are based on IAMs. At the Global Earth Summit held in Rio de Janeiro in 1992, the IPCC published a set of six scenarios (referred to as scenarios IS92a to IS92f: IPCC, 1992). Scenario IS92a was a mid-range scenario (often since described as "business as usual" or BAU). These were replaced with an updated set of scenarios for the Third Assessment Report of 2001 which tried to incorporate a broader set of assumptions about future socio-economic factors. Whilst the IPCC did not include an updated version of the 'Reasons for Concern' diagram in the 2007 Assessment Report, in response to the charge that the diagram required too much subjective interpretation, the 2007 report did include a written account of the physical impacts associated with temperature rises of between 1 and 3 degrees centigrade.

However, questions have been raised about the extent to which focussing on large scale events sufficiently overcomes the issues of subjectivity. Even in respect of such large scale changes there is little agreement because the causes, outcomes and likelihood are largely

uncertain and rely heavily on subjective judgements (Lowe et al., 2006: 438). Ramathan and Feng argue for a differentiated picture which recognises a range of threshold values of global and regional surface temperature change depending on the elements of the climate system that are being impacted by the warming (2008). Whilst the only way to accommodate the different vulnerabilities of different physical systems is to adopt the 1-3 degree range of dangerous impacts used by the IPCC in its 2007 Assessment report, such a wide range does not meet the demands of policy, which seeks a single, globally agreed target. This means a subjective decision is required as to what figure in this range is to be defined as dangerous. There are numerous examples of subjective decisions about what elements of the models to include and exclude in determining a single dangerous limit for physical climate change impacts. One of the physical impacts used by the IPCC to help policy makers define dangerous change regards increases in the number of people exposed to hunger as a result of drought and declines in agricultural yields (Hare, 2003: 70). The 2003 European heat wave, which occurred in a world 0.7 degrees centigrade hotter than the pre-industrial average, somewhat short of the two degree limit, was reported to have 'severely reduced European grain production, reducing stocks to the lowest level on record' (Lean, 2003). Additionally, news reports in 2008 and 2009 blamed rising food commodity prices, at least in part, on temperature rises. Article 2 also uses another definition of dangerous climate change, namely a rate of change which ecosystems would be unable to adapt to. On that measure it would seem dangerous climate change has already begun; in 2009 the Royal Society Technical Working Group claimed that coral reefs were already undergoing 'catastrophic' decline because of rising temperatures (2009: 3), a point reinforced by Smith et al. when they revisited the IPCC's 'burning embers' diagram (2009).

The idea that dangerous climate change is that which causes thresholds to be exceeded has been questioned on the basis that not all ecosystems will be prone to the same threshold, making identification of dangerous change very much case dependant (Parry et al., 1996: 3). If not all ecosystems have the same threshold, how many or which ecosystems must be pushed beyond their thresholds of adaptability before climate change is considered dangerous? (Leiserowitz, 2005; Parry, Carter and Hulme, 2001; Oppenheimer, 2005). Even just looking at one system, ice sheets, poses problems, as different ice sheets (for example the Greenland and the West Antarctic Ice sheets) have different sensitivities to warming. This makes their usefulness as indicators of dangerous climate change questionable (Oppenheimer and Alley, 2004: 263). Turning beyond a purely ecosystem focus requires comparison of vulnerability across a range of widely divergent situations. Is water deficit as strong an indicator of danger

as disease vulnerability or food shortages? Are several relatively minor impacts occurring together to be weighted equally with one large impact? (Oppenheimer, 2005: 1400).

Despite these uncertainties, the norm is to assume that the risk of crossing critical thresholds increases sufficiently beyond two degrees above pre-industrial for such a level of warming to be considered dangerous (Bierbaum et al., 2007; Oppenheimer and Alley 2004; Moss, 2007; WBGU 1995, 1997, 2003; International Climate Change Taskforce, 2005; Mastrandrea and Schneider, 2004; Gupta and van Asselt, 2004; Azar and Rhode, 2007).

3.7 Alternative definitions of dangerous climate change

WBGU reports exhibit a tendency to unreflectively substitute the term “dangerous” climate change for “acceptable” climate change. This thesis claims that the distinction is a critical one in the climate change debate. Dangerous limits are grounded in external definitions of risk which seek to identify the limit of warming in purely physical terms, and arrive at one single understanding of dangerous for all life. However, the IPCC recognises that any definition of dangerous rests on the level of risk deemed acceptable *(*WGIII 2007: 97*).* It is clear, therefore, that risk assessments cannot determine what is ‘dangerous’ purely on scientific bases without some judgement about what is acceptable (Pidgeon, 1997). Lorenzoni, Pidgeon and O’Connor argue that it is important to understand what values society will bring to bear to determine what society or individuals will ultimately come to regard as dangerous (2005: 1388). The ideal scenario is a body of rational actors using the scientific evidence in conjunction with individual value systems to build an aggregate picture of acceptable risk which would then legitimate the policies implemented to meet this acceptable risk level (Schneider, 2007; IPCC 2007; Sabatier and Jenkins-Smith, 1993; Lorenzoni, Pidgeon and O’Connor, 2005; Lowe and Lorenzoni, 2007). Elsewhere in the literature, rather than define limits as dangerous, the idea of tolerable change is conflated with acceptable change. It is not always clear whether tolerable means physically tolerable, or whether it refers to an ethical or moral limit. From an ethical perspective Lowe and Lorenzoni ask ‘how much change are individuals/societies prepared to tolerate?’ (2007: 1390). Lorenzoni et al., adopt an explicitly ethical definition of tolerability when they claim that tolerability and acceptability are socially constructed and highly subjective (2005: 10). The WBGU reports instead rely on a purely physical definition of tolerability to argue for a two degree limit, arguing such a rise would ‘constitute climate changes that are absolutely intolerable’ (1997: 18).

Variations in the level of human vulnerability to climate change, and the form that vulnerability takes is of increasing interest to researchers (Adger et al., 2009). This attention to

the relationship between culture and vulnerability has been linked to a 'second wave of adaptation studies, as opposed to the focus on purely physical impacts which defined the 'first wave' (Petheram, Zander, Campbell, High, and Stacey, 2010: 2). Vulnerability to climate change is defined as the degree to which geophysical, biological, and socioeconomic systems are susceptible to, and unable to cope with, adverse impacts of climate change (Schneider, 2007: 57). The focus on human vulnerability is aligned with the discussion of climate as a cultural category (see Hulme 2009, 2008, 2007, but also Fleming, 1998; Brody, 2001 and Lähde, 2006). Of particular interest is the vulnerability of the cultures of marginal and indigenous groups to climate change (Leduc, 2007; Petheram et al., 2010; Salik and Ross, 2009; Martello, 2008) wherein vulnerability is seen as a function of poverty, with poorer nations and communities being more vulnerable to climate change impacts than their wealthier counterparts (Eriksen and O'Brien, 2007). The reason for including indigenous voices in building climate change adaption practices is either based on concerns about equity and justice (Baer and Masterenda, 2006; Eriksen and O'Brien 2007; Sokona and Denton, 2001) or to ensure effective adaptation by using information possessed by the communities but lacking in the West (Patt and Schröter, 2008; Petheram et al., 2010). Subjective experiences of danger are not limited to variations in the ability to cope with the physical impacts. Often the danger has psychological dimensions, as expressed in terms of insecurity or lack of safety (Dessai et al., 2008). These perceptions of danger are determined by personal experience, values, information and trust (ibid).

Malnes has argued that a more qualitative understanding of danger might force us to consider the extent to which 'social well-being' might be undermined by changes in the climate. This metric is much more subtle and sensitive to change than that offered by ice-sheet disintegration. Questions of concern to this approach include what motives and values might be met, in which ways, so that society as a whole may further develop without undermining its long-term existential conditions? What do various groups of people perceive and believe about these questions; what worries them most, and which solution strategies would they favour? (2008: 663).

3.8 Discussion

This literature review has identified three primary sources of the two degree dangerous limit idea. Firstly, two degrees of warming is the mid-range projection of likely future warming found in the IPCC scenarios. Secondly, two degrees of warming is within the range of warming calculated by climate sensitivity modelling. Thirdly, two degrees of warming is deemed by cost-benefit analysis to be a target that can be achieved whilst maintaining economic growth. The

two degree limit originates in an economists' examination of the climate sensitivity data (i.e. Nordhaus, 1979), and thus it is plausible to argue that it is these two models (climate sensitivity and cost-benefit analysis) which are most important in defining and legitimating the two degree limit. This literature review has shown that these models rely heavily on value systems. Even the physical basis for determining danger is, in the face of great uncertainty, heavily influenced by values, for example by deciding on which changes are to be considered significant or dangerous.

In the next chapter I examine the extent to which policy making has influenced the selection of criteria used to define dangerous climate change. I argue that policy making requires a quantitative definition of climate change, and that this target must primarily meet the demands of elite interests.

Chapter 4

Theoretical Framework

4.1 Modernity, science and uncertainty

Modernity[36] has for a long time operated on the assumption that advances in scientific knowledge inevitably reduce uncertainty (Wynne and Jasanoff, 1998; Lövbrand, 2004), and that eventually science will deliver humanity into a state of complete certainty (Haila and Dyke, 2006: 41). Hulme and Dessai place the desire for the imposition of order on to a seemingly chaotic pattern of weather events to a broader desire to control nature that emerged during the embryonic stages of modernity in the 18th and 19th centuries, an order imposed through quantification and statistical analysis of weather patterns (2008: 3; but see also Sundberg, 2007). Nowotony et al. cite this belief in the ability of planning and predictability to deliver benefits as reaching its apogee during the period of 'high modernity' circa 1945-1960 (2001: 10), where the dominant assumption guiding interactions between humans and the non-human world was that all disorders can be made ordered through the expert application of industrial technologies (Hewitt, 1983: 202). Though this idea has come under increasing attack since the 1960's, to the extent that it has become commonplace in sociology to claim science is now just one story among many (Bauman, 1991: 243–4), Durant has cautioned against the assumption that such perspectives have impacted on the wider political and social influence of science, citing Wynne's assertion that science remains 'the default agent of public meanings' (Durant, 2008: 211).

Funcowitz and Ravetz argue for a post-normal science to rehabilitate a scientific response to the environmental problems of modernity (1993). Ravetz (2006a: 31) traces the need for a post-normal science to the awareness of environmental problems that first arose in the early 1960's with the publication of Rachel Carson's 'Silent Spring' (1962) and gathered pace in the early 1970's with the publication of 'The Limits to Growth' (Meadows et al., 1972).[37] A post-normal science is one which is able to recognise the possibility of irreducible uncertainties in our knowledge of the inter-actions between the open systems of society and global circulations of energy (Funcowitz and Ravetz, 1993; Ravetz, 2006). Funcowitz and Ravetz's call for a new for a new post-normal methodology is in line with Weinberg's ideas of 'transcience' (1972) which maintains that currently scientific questions are being asked of non-scientific

[36] I follow Giddens' definition of modernity, wherein modernity is 'the sum of the meanings, values and structures necessary for the reproduction of industrial society, as expressed through both the physical and discursive' (1991: 22). I would add that a key element of those 'meanings' and 'values' is the sense of constant movement towards a future of increased possibility. Yack argues that if 'it promotes a continuing activity of modernizing, or breaking with the past, then it is modern', a drive which is 'exemplified most strongly in ceaseless technological, scientific and commercial innovations of technological society' (1997: 36). See also Baumann (2000), Debord (1983), Ellul (1965), Zerzan (1994) and Ross (1991) for discussion of this theme.

[37] This book was published in the same year as the first Earth Summit hosted by the UN in Stockholm. These events are commonly deemed significant markers in the development of a global ecological consciousness.

problems. In terms of climate change, I understand this to mean that science is providing quantitative answers to essentially qualitative questions (Rayner, 1987: 19; Baer, 2005: 4; Shrader-Frechette, 1991: 57). Therefore the answer to the question 'How safe is safe enough?' must be:

> totally systemic, possessing no definitive answer. Also, defying any attempt at quantification, it belies the numerological reductionism that characterises our scientistic world view. This conundrum is perhaps the characteristic internal contradiction of our modern intensive technology civilisation.
>
> Ravetz, 2006: 14

In arguing that many environmental issues resist simplification through the reductive frames of normal science Ravetz urges his readers to view the idea of certainty in science as an impossible goal (2006a: 78). Instead, it is necessary to recognise that scientific activity is creating fresh uncertainty and instability, and should no longer be considered a terminus (Nowotny et al., 2001).[38] Rather than being the singular means of responding to environmental problems, science should instead become one of several inputs into the decision making process, a process wherein the ideal of rigorous scientific demonstration is replaced by that of open public dialogue which seeks to accommodate the plurality of legitimate perspectives (Ravetz, 2006b). Scholtz et al. call for trans-disciplinary processes as a key element in developing socially inclusive, representational knowledge. This requires the inclusion of knowledge and values from agents from the scientific and the non-scientific world (2000: 477). So, whilst science has a role in describing the landscape of uncertainties and facts, the discussion about how to respond to these situations should be a societal one, not the preserve of scientific experts (Evans and Plows, 2007: 828). These perspectives are a reflection of the unique status of environmental science as the most socialized, and thus most complex, of all scientific activity (Nowotny et al., 2001; Ravetz, 2006b; Longhino, 2002).

[38] Van der Sluijs uses the metaphor of 'monster' in his typology of epistemological responses to uncertainty. One can seek to *exorcise* the monster (remove uncertainty, i.e. normal science), *adapt* to the monster's existence by quantifying the uncertainties, *embrace* the monster (live with a spiritual wonderment at the world's complexity and surprises) or *assimilate* the monster. Monster-assimilation requires our frameworks for interpreting the world, and our expectations, to change in order that we can live with the ambiguity and pluralism in risk assessment. Post-normal science is a monster assimilation strategy (Van der Sluijs, 2005).

4.2 Climate change and globalization under modernity

Olausson describes globalisation as a leitmotif of modernity that is being reinforced by the transnational nature of environmental issues such as climate change, which are forcing us to think globally (2009: 421). If the problem is global, one privileges global solutions which embody a particular social order (Smith, 2007: 200). The global discourse assumes a shared future, shared perspectives, shared in this case meaning Western. Thus the UN Group of Climate Experts claim that 'Humanity must act collectively and urgently to change course through leadership at all levels of society' (Bierbaum et al., 2007: xviii). Roszak identifies such global constructions of humanity as an oppressive denial of personhood which has come to define the meta-narrative of modernity (1978).

Smith understands the dominant climate change discourses as a global 'gaze', a masculine construction that 'speaks of detachment and power, with nature as an externalized other' (Smith, 2007: 201). The idea of the climate change discourse as a discourse of power is echoed by Backstrand and Lövbrand, who see dominant constructions of climate change as increasing the reach of the state by legitimating a 'green governmentality' which seeks to extend control through technologies of power to the domain of the environment (2007: 127). This is a theme picked up by Wynne and Jasanoff, who suggest that climate change computer models such as global circulation models act as 'one of the markers of modernity' in that they create a centralized, all comprehending knowledge (1998: 59-60) which forces those outside the modelling community to put their trust in computations they do not really understand (see also Moss, 1995b: 34; Nowotny et al., 2001: 183).

Attempts to transform institutions within the bounds of modernity in order to meet ecological challenges are often conceptualised under the rubric of ecological modernization (Spaargaren and Mol, 1993; Dryzek, 1997; Schlosberg and Rinfret, 2008; Hajer, 1995; Clark and York, 2005).[39] Ecological modernization, in providing 'the dominant discursive space in which climate change is interpreted and conceptualized' (Dryzek, 1997: 131) requires the world to be constructed as 'planetary machinery in need of scientific management and monitoring' (Steffen, Sanderson, Tyson, Jaeger, Matson, Moore, Oldfield, Richardson, Schellenhuber, Turner and Wasson, 2004: 9). Consequently under ecological modernization all the roads that take us out of the environmental crisis are roads that lead us further into modern society (Spaargaren and Mol, 1993: 432). Ecological modernization might thus justifiably be described

[39] Descriptions of the various shades of green, and their relationships to different environmental management and coping strategies, can be found in, amongst others: Dryzek, 1997; Spowers, 2002; Jamison, 2001; Sutton, 2007; Martell, 1994; Zimmerman, 1994. Historical accounts of the development of green sensibilities have been provided by; Sutton, 2007, and Spowers, 2002.

as ‘yet another (and perhaps final) example of late modernity’s ability to appropriate and incorporate resistance to itself’ (Chouliaraki and Fairclough, 1999: 12). The rehabilitation of technology under ecological modernization and the rubric of ‘high-tec’ (Ezrahi, Mendelsohn, and Segal, 1994: 4) has been described as nothing more than a final and universal victory for the technical code, a complete colonization of the lifeworld (Feenberg, 2002: 140). This victory ensures we look to the principles and institutions of modernity to provide solutions to what is commonly described as the biggest environmental challenge yet to face humanity.

4.3 Constructing climate change

Whilst a large body of the social sciences literature argues for a constructivist and symbolic interpretation of risk, environmental policy remains grounded in a realist assumption about the nature of risk (Harrison and Davies, 1998: 3).

Social constructivism has been described as an investigation into the causes of belief, a querying of the social reasons why people do, or do not, believe a particular truth claim (Schneider, 2001: 339; Eden, 2004: 51). Constructivism is often associated with critical sociology. This is because the dominant construction of reality will normally be that of the dominant social actors (Patton, 2002: 100), and it is the exposure of how power operates which interests critical sociologists. This thesis uses a constructivist approach to examine why two degrees of warming has been defined as a dangerous limit, grounded in a realist assumption that globally averaged surface temperatures are rising in response to an increase in the atmospheric concentrations of greenhouse gases.

My research combines a broadly constructivist framework with elements of elite theory to explain patterns in the discursive representations of climate processes and change. The basic ontological assumptions which frame my examination of this subject are broadly aligned with critical realism. I recognise that there are (at least as regards the physical world) underlying structures and mechanisms which generate phenomenon, versions of which we construct through language (Somekh and Lewin, 2005: 123). The description of two degrees of warming as a dangerous limit cannot influence whether people are harmed by changes in the climate or not, but can define how that harm is understood and what relationship it has to constructions of a dangerous limit.

It is common in discussion of climate change to adopt a position in line with the critical realism used in my thesis. These approaches theorize risk as both factual and constructed, and maintain that the inclusion of scientific and calculable elements to the process of building

risk policy should not be at the expense of recognizing the social elements of understanding and responding to risk (Schraeder-Frechette, 1991; Ravetz, 2006b; Brown, 2003; Azar & Rodhe**,** 1997; Agrawala, 1999; Hulme, 2009; Martell, 1994; Eden, 2004; Pollack, 2003; Sayer, 2000). It is this attempt to understand climate change as a physical reality constructed in many different ways that leads Bray and Shackley to describe climate change as a 'quasi-reality', and claim a social-constructivist methodology as the best approach to understanding such a problem (2004: 2).

The difference between weather and climate serves as an exemplar of this balance between physical and socially constructed knowledge. Whilst the weather undeniably has objective physical qualities (if I stand out in the rain I will get wet) climate is not something which can be experienced directly but is a 'reified, standardised and quantified description of varied phenomena spread over a large period of time', sensible only to a global interlocking system of machinery generating data which has to be interpreted by the appropriately trained expert communities (Hulme, 2009: 6). Expert measurement of long term weather patterns is an essential process in constructing climate change as an issue of concern because for the individual, 'objective conditions themselves are not sufficient to promote awareness of a problem' (Yearley, 1991: 55). The process of defining empirical observations of changes in atmospheric chemistry as a problem is shaped by decisions about what counts as order and disorder, natural and normal, safe and dangerous. Definitions of the problem dictate what solutions are available, for whoever controls the definition of dangerous climate change controls the rational solution to the problem (Leisorowitz, 2005: 1441).

The important role played by institutions in the framing of the climate change problem means I am particularly interested in a norm centred form of constructivism in institutional discourses. This perspective assumes that institutional norms define acceptable behaviour and set expectations to which agents attach some sense of obligation. As an example, Pettenger has listed the norms at play in EU constructions of climate change as sustainable development, stewardship, equity, polluter pays, precautionary principle and economic efficiency (2007: 64). My thesis argues that whilst the EU has played a leading role in setting an internationally agreed dangerous limit to warming, assuming that a quantifiable dangerous limit exists and that it resides at two degrees of warming is an attempt to construct the problem in a way that addresses the needs of elite actors, rather than meet the demands of equity and precaution.

Spaargaren and Mol identify three constructivist approaches to risk in the social sciences; socio-psychological, cultural/anthropological and sociological (1993: 432). The distinction

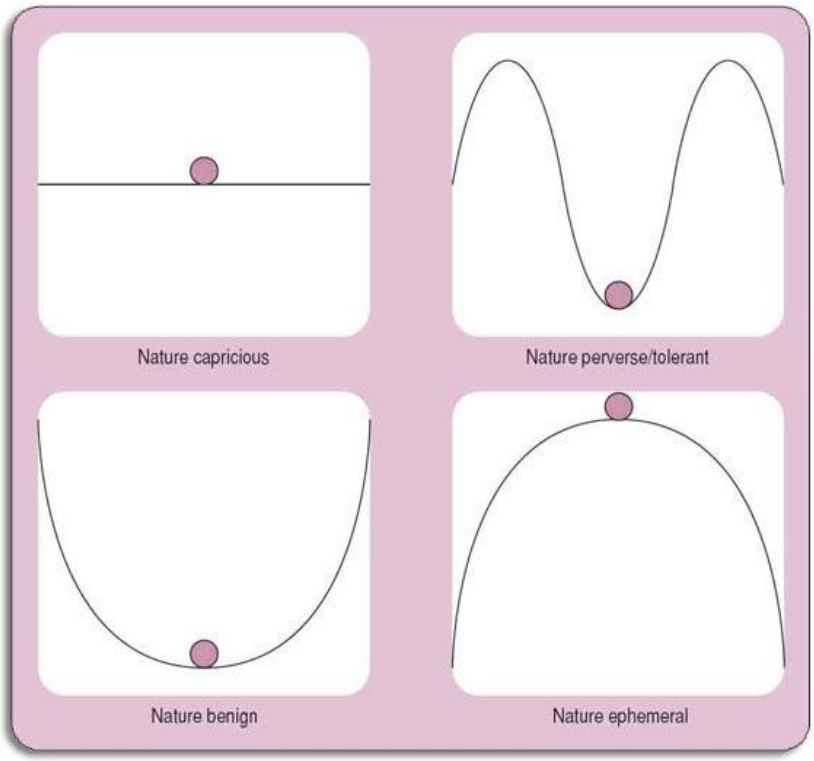
between these approaches is not hard and fast, but is more a matter of emphasis. All three approaches have some explanatory value for my research. Spaargen and Mol argue that the dominant approach in constructivist accounts of risk is socio-psychological, which tries to understand the cognitive processes giving rise to different perceptions of risk between lay persons and experts. I discuss the cognitive through examination of Moscovici's concept of 'anchoring devices' (1963) which I combine with accounts of the social amplification of risk (Kasperson, Kasperson, Renn, Slovic, Brown, Emel and Ratick, 1988) in examining media representations of the two degree dangerous limit idea. I outline cultural approaches by reference to Douglas and Wildavsky's typology of attitudes to risk (1982). I do not apply it directly to discussion of two degrees, but as a framework for understanding the themes employed in elite constructions of the dangerous limit concept - what tropes and entities are used to ensure certain culturally embedded value systems are recognised and validated by discussing climate change as a phenomenon with an identifiable and measurable dangerous limit? My main focus is on the sociological constructions of risk, as expressed through institutional and media treatments of the two degree dangerous limit.

4.4 Culture and constructions of climate risk.

Attempts have been made to map attitudes to environmental risk onto two typologies – Holling's four myths of nature (1986) and Douglas and Wildavsky's grid/group analysis (1982). Hulme in particular has made much use of these typologies in his exploration of the cultural dimensions of attitudes to climate change (2009). Inherent in such cultural analyses is the idea that these cultures are antecedent to the political and material forms of risk responses, and policy must work around and accommodate these competing value systems. This idea is in conflict with the elite theory model employed in this research, which I use to argue that particular meanings are imposed on the climate change phenomenon by the dominant actors in society as a knowing strategy designed to preserve the privileges enjoyed by these groups. Nonetheless, these typologies are prominent in the debate about responses to risk, and provide a useful framework for illustrating how attitudes are patterned across different groups. It is therefore appropriate to highlight the main features of the cultural approach to analysis of attitudes to risk.

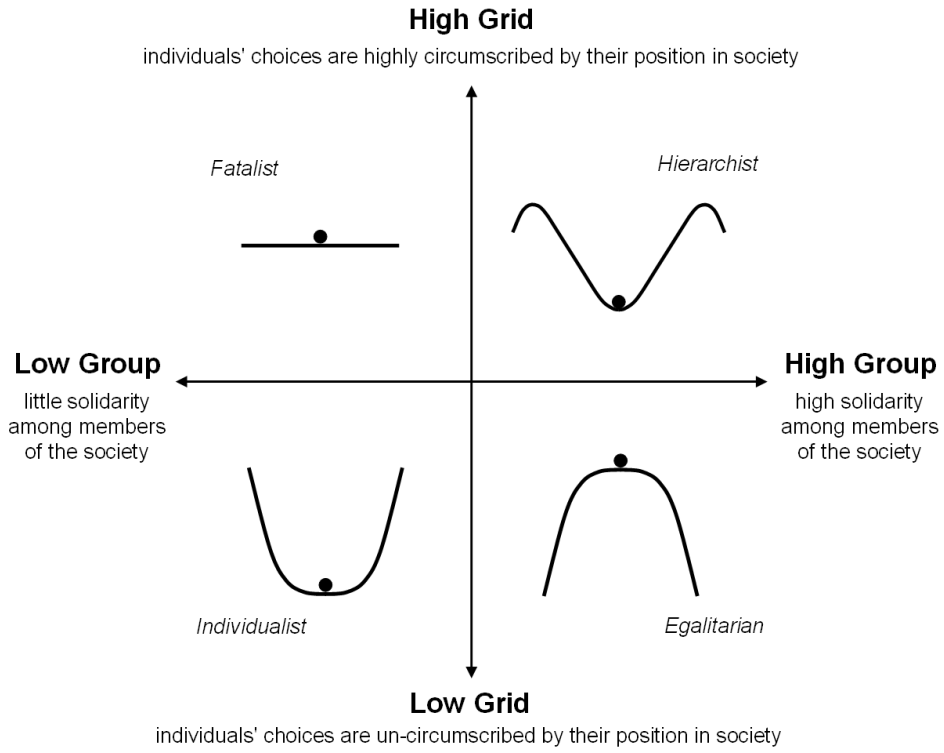
The first element of the culturally bound responses to risk relevant to discussion of dangerous limits to climate change is found in Hollings' 'four myths of nature'.

Figure 5: *Holling's four myths of nature (taken from Thompson and Rayner, 1998: 284).*



The following brief summary of the descriptions attached to this schematic has been pulled from Rayner and Thompson (1998: 284-285) and Hulme (2009: 188-191). In *Figure 5* the small sphere represents, for the purposes of this discussion, the ideal of a stable and safe climate. The line on which the sphere rests illustrates the nature of the conditions which are necessary for a stable climate. For those who consider nature ephemeral there are no safe limits. The slightest alteration to the background conditions will tip the climate away from its precarious state of balance. The 'nature perverse/tolerant' diagram sees the climate as robust, resilient and manageable within clearly defined limits. The top of the curve either side of the sphere represents the dangerous limit. Push the ball beyond those limits and the stability of the climate will be lost. For those who understand nature as capricious, human actions are deemed to be largely irrelevant to natural processes. The climate could tip either way as the consequence of non-anthropogenic forcing. The benign caricature of nature is in opposition to the idea of nature as ephemeral. The climate will return to a condition amenable to human existence whatever we do. According to Rayner and Thompson the two myths of nature (i.e. climate) as benign and perverse/tolerant have been placed together into the category of 'equilibrium' and it is the equilibrium myth which has prevailed in the industrialized world (1998: 285).

Figure 6: Mapping Thompson's Four Myths of Nature onto Douglas and Wildavsky's Grid/Group analysis (from Hood, 1999).



Douglas and Wildavsky (1982) understand perceptions of risk as grounded in peoples' view of their relation to others in society. Accordingly peoples' attitude to risk can be classified according to the extent to which they are group oriented or individualistic, hierarchical or egalitarian (Hulme, 2009: 185). *Figure 6* shows that the egalitarian belief that nature is ephemeral, i.e. fragile and sensitive to small disturbances, is associated with a desire for a more equal society. An example of this may be found in many deep green philosophies, wherein the damage done to nature is correlated with the damage humans do to each other in hierarchical societies (an example of this can be found in the work of green anarchist writers such Bookchin, 1980; and Zerzan, 1994). Rotmans and van Asslet associate the egalitarian response to environmental problems as 'preventative' (2001: 130). The 'high group' orientation of the egalitarian is also associated with the hierarchist, but this latter cultural category sees the important elements of group orientation existing within a stratified, rather than egalitarian, social order. The hierarchist is associated with an attitude to nature which supports the idea of a stable climate within limits, that environmental outcomes can be managed to provide sustainable outcomes (Hulme, 2009: 186). Rotmans and Van Asselt describe the hierarchist approach to environmental problems as one of 'control' (1996: 130).

Fatalists and individualists have only a limited fidelity to the conception of themselves as social actors. Fatalists may be associated with a sense of victimhood, as having little autonomy or control over their fate. Those occupying subordinate or marginal positions in society ('sectarians') are removed from the centre of power and so attack the risks chosen by those who are at the centre (Shrader-Frechette, 1991: 17). Bronstein identifies these atomised and subaltern actors as experiencing a greater sensitivity to socially imposed dangers than elite actors (1984: 213).[40] They likewise see the climate as impervious to human control, as something too big to be overly affected by human action. The individualist is associated with the idea of the entrepreneur, likely to view the social and natural as resources to be used to aid self-fulfilment. They do not consider such attitudes as damaging to the environment, and are associated with the idea of "adaptation" as the appropriate response to climate change and other global environmental problems.

It has been claimed that the grid/group analysis is widely used in analysis of responses to environmental issues because it offers a unique degree of explanatory power (van Asselt and Rotmans, 1996: 130-131). Kahan has shown that the grid/group frame models an observed cultural conditioning of attitudes to risk. People endorse whichever position reinforces their connection to others with whom they share important commitments. The same groups who disagree on 'cultural issues' - abortion, same-sex marriage and school prayer - also disagree, for example, on whether climate change is real and on whether underground disposal of nuclear waste is safe (2010: 296). Lowe and Lorenzoni contend that for hierarchists and individualists climate change represents an ideological rather than a physical hazard, a direct challenge to the value systems of these cultural types (2005: 21). Leisowitz (1996) and Everneden (1991) interpret these cultural biases as grounded in particular preferred ways of life. Risks are changes which present a threat to this way of life. For the hierarchist and individualist the risk is less environmental and more about legislation which threatens or inhibits opportunities for profit seeking activity.

A cultural approach is useful to discussion of attitudes to uncertainty in climate change because, as was noted above, the public are highly dependent on expert interpretations of climate data and projections, and public attitudes to expert discourses are culturally defined. However, whilst the grid has some value as an heuristic tool it does not explain why people hold the beliefs they do, how those beliefs might change, or why the hierarchist/individualist cultural values (i.e. capitalist ideologies) dominate risk responses (O'Riordan and Jordan, 1999:

[40] This simple dichotomy has been challenged by Shrader-Frechette who notes that the environmental movement is dominated by well educated white people from the middle-classes, rather than those furthest removed from the centre of power (1991: 21), a point reinforced by Martell's analysis of environmental movements (1994).

88). Thus, whilst combining Hollings four myths of nature with Douglas and Wildavsky's grid-group analysis reveals a close connection between social positioning and attitudes to nature, it does so without explaining if one is the cause of the other.

4.5 Anchoring and constructions of climate risk

Anchoring describes the means by which people come to understand an unfamiliar event. People can only make sense of the world by finding ways to reconcile their beliefs with some set of facts about how reality must operate (e.g. Schon and Rein, 1994). To anchor an object is to fit it into an existing system of classifications, is to name it and relate it to other objects in the system (Wells, 1987: 443). Moscovici seems to be the first thinker to explain the role of anchoring in knowledge production, and uses the term 'social representations' (1963) to describe the way new ideas are taken up by, or communicated to, the public. The process of social representation involves anchoring, comparing a foreign object to already known systems or categories. Anchors allow groups to make sense of novel risks by classifying and naming the threat, thus making the unfamiliar familiar (Washer and Joffe, 2006: 2143). Another process in the evolution of social representations of a novel phenomenon is objectification, which saturates an unfamiliar entity with more familiar images, objects, symbols. Anchoring in this way overlaps with symbolisation, providing people with a means to experience abstract content. A gradual process of familiarisation, discussion and use, simplifies the idea into a single image. Eventually the image is entirely assimilated into a framework of representations, and becomes an element of reality rather than of thought, an unmediated fact (Wells, 1987: 444).

The most notable use of the anchoring concept in discussion of climate change risk features in the work of van der Sluijs et al., on the fixing of the climate sensitivity range (1998). The authors sought to explain why, given the uncertainty surrounding climate modelling, the climate sensitivity range had remained so stable over a thirty year period.[41] The authors seek to explain this puzzle by theorizing the idea of the climate sensitivity range as an anchoring device which acted as 'a highly stable boundary-object in a context of scientific and social flux', and 'seems to function as a means of managing uncertainty...and thus serve to constrain the discourse' (ibid). Boundary objects sit between two different social worlds (like science and non-science) and can be used by individuals within each for specific purposes without losing

[41] For example see the 1979 report from the National Academy of Sciences which identified the most probable global warming for a doubling of CO_2 to be near 3°C with a probable error of ±1.5°C.

their own identity (Guston, 2000: 7). To function effectively the boundary object has to be anchored in the way described by Mosovici, meaning the object needs to be saturated with meanings that are familiar to all the relevant actors.

4.6 Constructing environmental limits

Habermas (1998) has shown that it is important for the state to be seen to be doing something when an environmental problem is identified. Doing something means controlling events in order to get a predictable outcome (Bronstein, 1984). Defining and agreeing targets, and building a network of institutions and events such as conferences to implement those targets provides the appearance of action and progress towards a solution, rather than helplessness. In addition quantitative targets act as 'first order questions used to divert attention away from questions about the political and social order' (Smith, 2007: 202). The ability to weigh outputs such as emissions against climate change targets is essentially a technological exercise, requiring global networks of surface and atmospheric monitoring devices. This further erodes any sense of climate change as a political issue for, as Dickens observes, defining technological solutions as the correct solutions to environmental problems in effect makes political and ideological choices appear to merely technical matters (1992: 157). Therefore the quantification of the climate change problem not only serves a vital anchoring function, tying the climate change problem into common experiences such as speed limits (Jaeger and Jaeger, 2010), but it also frames climate change as a technical issue which can be managed through the framework of modernity (Weingart, Engels and Pansegrau, 2000: 263; Haila and Dyke, 2006: 187).

Hulme claims that the desire to conceive of the world in simple dichotomous terms of dangerous/not dangerous tipping points is the product of a culturally grounded way of believing (2009: 60). However, the elite theory model instead argues that the ontology of safe/not safe is a conscious act of power, an inherently political act which is in fact integral to modern day politics and science (Ravetz, 2006a: 74; Ross, 1991: 6). Rather than reflecting objective properties of the physical world the 'meaningless precision' of clearly defined safety limits (Funcowitz and Ravetz, 1994: 93) serves an important ideological function, it being 'continuous with the scientific perspective of quantitatively dominating the physical world' (Ross, 1991: 208). The claim that science can identify dangerous limits is, for Ross, essentially normative and fulfils a political function: 'Calculations surrounding our ability to survive in a dramatically altered natural world are presented rationally so as to deny the irrationality of the actions generating the crisis' (Ross, 1991: 136).

The institutional determinants of risk definition and scientific risk modelling have been traced back to the development of the civil nuclear industry, and the American Atomic Energy Commission's use of probabilistic risk analysis in the 1950s to assess the maximum credible chance of a nuclear reactor accident (Ravetz, 2006a: 72).[42] Ravetz describes the uncertainties in civil nuclear power as 'overwhelming', but that it was necessary to deny the impossibility of defining the nature of the risk in order to legitimate the development of a nuclear power industry (ibid). These risk assessments included the first attempt to define a dose-response dynamic, in this case for exposure to radiation.

Commoner (2003) argues that such efforts required the official denial of the fact that there is in fact no safe limit for exposure to radiation and other carcinogens. In the 1960's the Occupational Health and Safety Administration in the US was engaged in a dispute with an industry body (the American Industrial Health Council) over acceptable levels of exposure to the carcinogenic substance benzene. The Occupational Health and Safety Administration sought to develop worker health and safety legislation on the basis that there is no reliable way of determining a safe threshold for substances such as benzene, whereas the American Industrial Health Council argued for the establishment of such a level (Commoner, 2003: 35). Such findings indicate that attempts to identify safe limits are orientated towards the legitimation and maintenance of potentially harmful industrial practices which, absent the "safe limit" would be stopped or drastically curtailed.[43] The belief in safe limits requires a dichotomous world view, where systems and individuals are defined as impacted/not impacted (Tickner, 2003: 9). Commoner claims that where that assumption is successfully challenged the idea of a safe limit has to be abandoned (2003: 33). It seems therefore reasonable to argue that articulating a world view which divides safe from dangerous, impacted from not impacted, can be an act of power (Leisorowitz, 2005: 1441).

Bronstein identifies a symbolic element to the social construction of risk. The manipulation of symbols can be a key technique of social control; if the public accepts a particular definition of a problem then they will generally consent to the actions the powerful wish to take (1984: 219). The social construction of risk involves competing efforts between different

[42] The use of probabilistic analysis in those studies was reviewed in the Lewis report of 1979 which officially sanctioned the use of probabilistic analysis in risk assessments (Cooke, 1991: 28). As demonstrated in the literature review, probabilistic analysis is integral to the IPCC climate change projections which have been used to justify a two degree limit.

[43] A clear example of the enabling function of safe limits was apparent in Europe in April 2010 when volcanic ash from a volcano eruption in Iceland grounded a large number of flights. The Civil Aviation Authority had no safe limit for volcanic ash prior to this episode. All atmospheric concentrations of volcanic ash were defined as dangerous and so flights were grounded while there was volcanic ash in the fight paths. Following pressure for six days from aircraft operators a limit higher than actual concentrations was agreed. Agreement on this limit allowed flights to resume (*Was the flight ban necessary?* BBC News Online, 2010).

organisations to ensure their symbolic representation of the danger becomes the dominant one (ibid). This struggle to maintain a particular symbolic definition of a problem pulls on the esteem of science to give a value position the appearance of fact, because an ideological position 'can never be really successful until it is naturalized, and it cannot be naturalized while it is still thought of as a value rather than a fact' (Fisher, 2009: 16).

4.7 Key actors in the construction of the two degree dangerous limit

4.7.1 Media

The elite theory approach I draw on in this study is not so much concerned with identifying and naming elite actors. Rather, my focus is on how elite interests, as articulated through the core imperatives of the state, are legitimated through the use of language. The mass media are the key institutional actors in this legitimation process. Consequently, as regards the topic of my research, I argue that contest for control of how to interpret climate science occurs primarily in institutional settings, with the mass media constituting the most important of these institutional settings, at least as regards public attitudes to climate change (Doulton and Brown, 2000; Carvalho and Burgess, 2005; Koopmans, 2004; Martell, 1994; Risbey, 2007; Olausson, 2009).

Weingart, Engels and Pasengrau make the point that modern societies are characterized by a much closer relationship among science, politics, and the media than has hitherto been the case. Consequently science is increasingly called on 'to make pronouncements on issues that potentially concern the safety and well-being of the population at large, and are thus of immediate political relevance and have a high news value for the media' (2000: 261).The media act as social stations of risk amplification in such circumstances, but this role can bring the media into conflict with its other functions (Kasperson, Kasperson and Jaherin, 2001: 18). For example, promotion of international travel by commercial news outlets, and gaining revenue from the associated adverts, is in conflict with news reports showing that such activities are, at the level of the individual, making a significant contribution to atmospheric increases in CO_2. I argue that positing climate change as a problem for the future, once we cross the dangerous limit, goes some way to accommodating these tensions and allowing for the immediate continuation of those practices.

Another tension arises from the need for media outlets to provide coverage for a wide range of stories. The public sphere is a bounded space for political communication characterized by a high level of competition. This means the media acts in a gate-keeping role, deciding what

messages will be displayed with what importance. Carvhalho and Burgess argue that 'different social actors (scientists, politicians, policymakers, businesses,[44] pressure groups, and media professionals) are locked in discursive competition around how climate change risk is to be framed in the media' (2005: 1458). The media often privileges what it deems to be the most credible and authoritative voices on a particular topic. Credibility and authority, from the perspective of the media, normally reside with the most powerful actors (Allan et al., 2000: 13).

There are four theoretical positions germane to my examination of the media's role in the construction of credible story lines about climate change limits; political economy, organizational economy, evolutionary models and cultural theory. Organizational economy understands news agendas to be driven by the internal culture and economics of the newsroom, and the skills of the journalists employed (Klinenberg, 2002; Smith, 2005). Davies pulls on this theory to explain what he sees as a failure of the media to fulfil the role of holding power to account. Increased pressure to churn news across a diversity of "always on" media outlets, combined with reduced income and staff puts pressure on journalists to rely on unchecked sources and press releases (2008).

The evolutionary model lends credence to organizational economy explanations for media performance. In the bounded public sphere a variety of actors, interests and organizations compete for the scarce resources of public attention. The balance of discursive power evolves over time in response to these competitive pressures so that the form taken by mediated information is to an important extent influenced by past media discourses (Koopmans, 2004: 373). That is to say, organizations learn how to provide media outlets with the stories they will reproduce in a timely and relevant fashion. Over time, the media increasingly turn to these organizations for the information they need, rather than wasting time and resources searching elsewhere for that same information. Consequently, news rooms are developing ever more deeply entrenched organized relationships with institutions seen by media actors as the most credible players. This results in a tilt towards powerful elite sources which provide a predominantly establishment view of the world (Mautner, 2008: 33).

Cultural theory argues news stories need to be framed in ways which resonate with existing and widely held concepts and values, otherwise the business concerned will lose readers and therefore income. Political economy is aligned with elite theory and argues that the media, along with a range of other social activities such as schooling and popular culture, operates to

[44] There is little evidence in the literature of profit seeking institutions engaging directly with the dangerous limits debate, presumably because the idea of limits is generally seen as anathema to industrial culture (Douglas and Wildavsky, 1982; Dryzek, 1997; Ross, 1991).

serve the interests of the dominant groups in society (Chomsky and Herman, 1989; Chomsky, 2002; Edwards and Cromwell, 2009). All these approaches theories offer some explanatory power, but this research will rely primarily on political economy explanations, and how these theories explain the frames through which the media reports on climate change and climate science.[45] I use political economy perspectives on media activity as it is these which most closely align with the elite theory approach informing my research. I therefore argue that the purpose of the media is 'to inculcate and defend the economic, social and political agenda of privileged groups that dominate the domestic society and the state' (Chomsky and Herman, 1988: 298). As I outlined in the introduction, outside of the core state interests, there is scope for pluralist perspectives to offer some limited explanatory power. The media will offer some dissenting voices, but this is still largely a propaganda function. Ellul cites the case of *Krodokil*, a Soviet newspaper allowed to be critical of the communist state, because the state understood it would be catastrophic to suppress criticism '*as long as the criticisms had no serious consequences'* (Ellul, 1965: 424. Emphasis added). I emphasise this last point because I understand that issue to define the limit of pluralism, serious consequences here meaning serious consequences for the core functions of the state.

Frames act as organizing ideas, or cognitive windows which relate a particular version of the topic being reported (Oluasson, 2009: 423). Olausson's research into media constructions of climate change, drawing on elite theory, makes the case for an analysis of media discourse which locates the frames used within a network of cultural, economic, and political factors and argues that:

> Frames, as imprints of power, are central to the production of hegemonic meanings. The examination of the relationship between hegemony and media frames also includes the uncontested realm of media discourse, resulting in frames appearing as transparent descriptions of reality, not as interpretations.
>
> Oluasson, 2009: 223

Oluasson describes the use of these frames as 'uncontested, because frames are often taken for granted, not subject to any kind of questioning, and are therefore invisible in everyday practice' (ibid). It is this invisibility which makes frames such a powerful hegemonic device

[45] Chapman and Kinsey (2009), following a series of interviews with environmental journalists concluded that while the news agenda is comprised of 3 different agendas – media, public and political, it is the political agenda which is the dominant one (42). Klhaen and Mullen conclude that the political economy model used by commentators such as Chomsky and Hermann has not suffered any serious challenge as an explanatory model of media frames (2010).

(Newell, 2000: 77) ensuring the interests of the elites are embedded, without challenge, into the system (Roberts, 2004: 149).

Most research in mass communication has found journalism to be profoundly conservative in support of existing power structures and the status quo (Holstein and Stocking, 2008; Chomsky and Herman, 1989; Hallin, 1986; Gitlin, 1980; Gans, 1980). This extends to a widespread respect amongst journalists for expert and scientific knowledge (Weigold, 2001). Pollack attributes this respect to the fact that journalists and scientists share the same intellectual foundations (2003: 23), which may explain the laudatory comments on science and scientists which Duran has identified as being prominent in the media (1997: 111). Yet the media reporting of science is widely held to be far less nuanced than the science itself (Klein, 2010; Doulton and Brown, 2007; Holstein and Stocking, 2008), and as unable to accommodate the possibility of irreducible uncertainties in climate science (Smith, 2005: 1475; Ziman, 1991: 189). The purported balancing norms present in media reporting identified by Boykoff and Boykoff (2004) drives the media to report challenges from groups and individuals who feel their interests are being threatened by particular scientific findings, which can further distort the reporting of science, for example by giving space to accounts which underplay the likely impacts. On the other hand Smith, discussing his research into the reporting of science in the media conducted at a series of seminars hosted by the BBC, notes that NGO actors, policy makers and scientists present at these seminars accused the media of failing in their duty to report the science accurately by often exaggerating the dangers or attributing particular events to climate change without any scientific justification (2005: 1473).

Newell claims the media have turned the climate change issue from one which is a challenge to industrial processes into an environmental problem pretty much like every other, its resolution easily accommodated within existing political and economic practices (2000: 68). This is largely achieved by ignoring more unconventional and challenging accounts, thereby establishing the boundaries within which public understanding of climate change takes place (Newell, 2000: 88). Carvhalho and Burgess cite research which relies on the values of “progress” to promote technological fixes to climate change over ethical and political choices (2005: 1467). Doulton and Brown reinforce the importance of the media as a source of information on climate change for the public, but argue that climate change is ideologically constructed in different ways in different UK newspapers (2009: 199). For example they identify “potential catastrophe” as by far the most dominant frame used in the previous decade, but that it figured much more frequently in the Independent and Guardian newspapers than in the Times and Telegraph.

The relationship between the media and the public is not a simple one of direct linear transmission of scientific knowledge. Instead climate science becomes circulated through various institutions and interests groups, meaning that what is required is an 'ecology of knowledge' (Akera, 2007: 413). An example of this circulation of knowledge can be found upstream from the media report, with research showing that the balance of sources cited in climate change stories has shifted from scientists to politicians, interest groups, NGO reports and outputs from policy-science boundary organizations (Doulton and Brown, 2009; Corbett and Durfee, 2004; Guston, 2000). Downstream from media activity, information interacts dynamically with psychological, social, cultural and institutional factors resulting in amplification or attenuation of individual and social perceptions of risks (Kasperson et al., 1988).

These dynamic interactions do not negate a political economy explanation of media activity, but instead show how important it is that the media stick to repeating simple tropes voiced by authoritative actors and institutions to overcome these distortions, thereby ensuring the core messages are received as intended. Therefore if, for example, the communication source is described as an independent scientist, or a group of Nobel laureates, the content of the message may well command public attention and increase the receiver's tolerance for weak evidence (Kasperson et al., 1988: 22). Repetition is also a key element of ensuring a message is perceived as valid: 'A factual statement repeated several times, especially if by different sources, tends to elicit greater belief in the accuracy of the information' (ibid: 180).

4.7.2 Environmental campaigners

The role of environmental pressure groups and NGOs in shaping policy has long been of interest to social researchers. Pluralist theories stress that policy options are dictated by public opinion and that environmental campaigners have a key role in shaping public opinion on environmental issues (Dunleavy and O'Leary, 1987; Carter and Ockwell; 2007). It has been argued that environmental campaigners act as 'norm entrepreneurs' in the climate change debate (Sunstein, 1996) and that they are heavily reliant on ideas of danger as a driving plot device in their media campaigns (Smith, 2005: 1473). The strength of campaigners in shaping public opinion and environmental policy has been treated more critically elsewhere (Roberts, 2004; Dryzek, Downes, Hunold, and Schlosberg, 2003; Jamison, 2001; Pettenger, 2007; Newell, 2000). Elite theory supports Dryzek's argument that environmental NGOs have very limited influence on environmental policy, concluding that success is limited to demands that do not impact on the core imperatives of the state. These imperatives are domestic order, survival,

revenue, economic growth and legitimation, which together comprise the 'zone of necessity which features only limited democratic control' (Dryzek et al., 2002: 663). The dominance of these core imperatives in policy making, and the fact that these imperatives conflict, at least in part, with the green agenda, leads Dryzek to conclude that whilst some states are greener than others, there are no green states (1997: 2). Darier has argued that environmental NGOs are adverse to relativist accounts of risk (1999: 4), and rely heavily on instrumental and empirical story lines to promote their cause, for example by focusing heavily on the "two degrees is a dangerous limit" trope. Other researchers have expressed concern that environmental campaigners and NGOs are abandoning science and evidence based communication strategies to promote the sense of imminent climate catastrophe (Smith, 2005; Hulme, 2006; Eraut and Segnit, 2007). From this latter perspective, environmental campaigners are citing particular weather events as evidence of climate change, or are exaggerating the likely future impacts of climate change.

4.7.3 Climate change policy institutions

Decision making power under modernity has taken institutional form. This is especially true of the trans-national environmental problems that have emerged since the latter part of the twentieth century. Rayner and Thompson explain how the increasingly important role played by international institutions in human affairs has given rise to a revived interest in institutional explanations, supplanting rational actor theories, wherein the social was explained by aggregating individual utility maximisation strategies (1998: 322-323). Institutionalism in sociology refutes this notion of agency, arguing instead that it is institutionally embedded rules, not individual actors, which guide political action (ibid). O'Riordan and Jordan (1999), have examined in length how these institutionally embedded rules influence political action. The concept of institutions is very broad, ranging from formal deliberating bodies engaged in treaty making to the informal liaisons among a range of different decision making and non-decision making communities and actors. However, despite this variety, what defines all these interactions as institutional is the 'presence of some sort of order and guiding principles of social solidarity' focused around a 'locus of regularized or crystallized principle of conduct that governs a crucial area of social life and that endures over time' as a key characteristic of institutional behaviour (O'Riordan and Jordan, 1999: 346).

Whilst institutional interactions happen at a wide range of scales Kasperson et al. note that it is the larger, more powerful institutions that are the primary players in setting the terms about society's discussion of risks (1988: 18) and that it is only these large transnational institutions,

such as the IPCC, which are capable of managing and understanding climate change (O'Riordan and Jordan, 1999: 347).

Underlying the writing of the UNFCCC and the formation of the IPCC is the idea that the causes and impacts of climate change can be controlled through the use of science based international agreements. International regimes predicated on these assumptions are operating within what Sunderlin has described as a 'managerialist paradigm' (1995: 212). The managerialist paradigm assumes that the origin of environmental problems lies in inadequate policies of international and national governing institutions, and that the solution therefore lies in improving those policies, by creating a new regime. An international regime is defined as a system of norms and rules specified by a multilateral legal instrument, normally a convention (Porter and Brown, 1991: 20). Broadhead has expanded this definition of a regime, which she characterizes as a set of implicit or explicit principles, norms, rules and decision making procedures around which actors' expectations converge (2002: 106). International regimes have to date been dominated by economic norms (Cass, 2007). The increased dominance of international finance means states are more cautious in adopting policies which will reduce the likelihood of internal investment (Paterson, 1996: 194). It is because green diplomats have to negotiate against a backdrop of the established economic order that the resulting environmental regimes are so flawed as to be virtually worthless (Broadhead, 2002: 103). Sunderlin has highlighted the opinion of several writers that 'global governance, generally speaking, is probably impossible' (1995: 216).

Some writers have sought to portray the institutions of the EU as an exception to these norms, and instead argue that the EU is seeking to implement a set of regimes which constitute an ecological norm for the community leader (Jordan, 2008; Schlosberg and Rinfret, 2008; Gerhards and Lengfeld, 2008). Jordan cites a 2006 statement from a UK Environment Minister as evidence of this claim, in which the minister remarks that the EU's 'raison d'être in the 21st century must be to prevent the exploitation of the planet. The European Union must become the Environmental Union' (2008: 486).

For idealists, institutions seeking to cope with environmental problems are 'boosting concern, building capacity, and facilitating agreement' among participants. Idealists often point to the success of the Montreal Protocol in regulating CFC emissions as an example of building successful international environmental regimes (Sunderlin, 1995: 215). Substituting liberal for idealist, Roberts identifies the liberal institutionalist's optimism about the building of environmental regimes as being grounded in a belief that regimes can be developed along rational co-operative lines that are somehow divorced from the power–maximization strategies of individual states (2004: 148).

Realist approaches to regime building are more critical, and are closely aligned to elite theory. The realism paradigm sees international relations as a power struggle in an anarchical world, whereas neo-realists adopt the position that co-operation is only achievable under the hegemonic power of one state (Porter and Brown, 1990: 28). Roberts identifies an elite theory approach to the study of international regime building which, in opposition to pluralist accounts, assumes the government is the agent of the capitalist class, and most decisions serve the interests of this class (2004: 148). From these critical perspectives international conventions are seen as little more than window dressing, which give the impression of participation whilst business continues as usual (Porter and Brown, 1990: 372). Absent any facility for imposing agreements on powerful states international policy tends to be diluted to the level acceptable to the least enthusiastic state (2004: 177).

4.8 Institutions and uncertainty

Under conditions of empirical uncertainty, such as those characterising climate change projections, institutional setting alongside social and political values come to play a determining role in defining what is true (Johnson and Covello, 1987: 357). Wynne and Jasanoff argue this is especially so in the case of complex problems requiring global co-ordination of responses, because knowledge production can be universalised only through a complex and fragile social production infrastructure. Therefore the 'global reproduction of knowledge is more dependent on the institutions involved than the facts themselves' (1998: 20).

Eden draws on ideas from organization theory to show how institutions absorb uncertainty and turn it into fact (2003: 59), a point repeated by Cooke (1991) and Hind (2007). Cooke argues that decision makers place great weight on the uncertain opinion of experts and do so in a rather unmethodological manner, but that this informal and subjective process is black boxed through the formal communications of institutions and think tanks (1991: 5). Turner looks back to Festinger's work from the 1950s on social reality to explain how consensus is achieved in situations where data is sparse. Social reality functions to provide validity for a person's subjective beliefs in the absence of the ability to test the belief. In the absence any proof or ability to test a proposition, subjective validation becomes dependant on consensual validation. A belief is correct/proper to the extent that it is anchored in a group of people with similar beliefs opinions and attitudes (1991: 454). Group uniformity becomes an increasingly important determinant of decision making the greater the level of uncertainty. Consensual validation takes place within the boundaries defined by the institutional norms. Cass argues it

is important not to overlook the important role played by material incentives in ensuring actors accept the norms operating in the process of reaching consensus; these norms do not necessarily reflect the beliefs of most actors, but are just a calculated norm compliance designed to secure benefits and avoid costs (2007: 25).

The ultimate goal of constructing problems so that they are aligned to the organizational frames of dominant institutions is to make them amenable to 'political regulation' (Weingart et al., 2000: 263). Moss contends that this demand for institutions to frame problems in such a way as to ensure policy relevance has influenced the practice of climate science, shaping the formulation of research questions, choice of methods, standards of proof (1995b: 172). The demand for policy relevance means climate change institutions have turned climate change into an instrumental technocratic project embedded in expert oriented and publicly inaccessible storylines that favour policy and research elites (Bohemer-Christiansen, 2003: 128). This, it is claimed, suits science for policy which seeks clear and simple answers, but does grievous violence to our ability to find real solutions (Moss, 1995a: 6).

The framing of climate change as a phenomenon manageable through existing political structures prevents institutional responses from raising any fundamental challenges to the structures and practices which characterize existing social relations and values. The demand for problems to be aligned with the organizational frames of policy making means that the development and application of knowledge follows not from nature itself but from these organizational frames (Eden, 2004: 37). Crenson has described organizations as 'the mobilization of bias' (1971: 23) by which he means that organizational frames do not develop out of a socially inclusive democratic debate, but reflect the agenda of the most powerful interests in society, a point echoed by Bronstein (1984: 200). The unreflective use of these frames sets up a positive feedback loop of self-reinforcing path dependant processes. Eden describes how the self-reinforcing relative benefits of current actions compared with other choices increases over time. These processes become increasingly efficient as infrastructure and experience of them increases. Consequently past organizational choices become reified, and organizational ontologies, discourses and categories become, for the organizations members, attributes of the world rather than mere conventions (2004: 52).

In his study of political responses to air pollution, Crenson explains how power relations act to exclude certain options and responses from the organizational frames employed by city authorities. This power is used to create or enforce social, political and institutional practices and values which limit political processes to those issues comparatively innocuous to the holder of power (Crenson, 1971: 21). Lukes talks of a second dimension of power to explain the way certain issues are kept off the political and institutional agenda (1974). Newell, in his

analysis of the influence of NGOs on international climate change policy cites Kripps identification of 'non active forms of power' (2000: 176). Thus, rather than look for evidence of conflict to see whether or not power is being exercised instead one needs to illuminate the ways in which, and reasons why, actors adjust behaviour to actual or anticipated preferences of others (ibid). Consequently institutional discussions of risk are in fact discussions about power, 'the power to impose risks on the many for the benefit of the few' (Perrow, 1984: 306). Tickner believes issues of risk and environmental policy 'cannot be separated from questions of economics, political power and institutional capacity and will' (2003: xvi-xvii). Adopting a Marxist perspective, Castree argues that definitions of environmental risk are entirely conditioned by the limits imposed by the historically and socially situated conditions of its production under the aegis of capitalist institutions (2000: 13).

4.9 Discussion

This chapter has put forward the argument that in the face of empirically underdetermined visions of future climate change impacts, there is an institutional flight to, if not certainty, then at least some fixed meaning which can be used to define targets which provide a framework for policy. What this fixed meaning should be is determined by the most powerful institutional actors, away from the public gaze. Defining a shared meaning allows these actors to then shape a collective response. It is important for policy actors to construct a meaningful narrative about the climate change phenomenon in order to develop a strategy which communicates control. By communicating a sense of control, and the ability to keep the public safe, existing political structures legitimate their existence. There is no challenge to the idea of a two degree limit in the public sphere because the media shares the same values embodied in these institutional responses. Environmental actors share the same positivist approach to environmental problems as characterised by dominant establishment discourses. Alongside this, these actors recognise any attempt to communicate a strategy which challenges the core imperatives of the state will fail. Additionally, campaigns which incorporate values from outside the cultural mainstream will not be reported by the media. Any construction of dangerous climate change which seeks traction with the public must be able to accommodate at least some of the cultural prejudices mapped in Douglas and Wildavsky's grid/group analysis. The novel nature of the climate risk requires which ever frame that is used to be anchored with symbolic meanings familiar and stable enough to be understood by a wide variety of actors in a range of cultural settings, without challenging the legitimacy of existing economic norms.

Chapter 5

Methodology

5.1 Introduction

The goals of my research rest on the claim made by Barnes and Bloor (1996) that a sociologist, whether or not she evaluates a belief as true or false, must search for the causes of its credibility. This chapter explains the methodologies I use to identify why the two degree limit is seen as credible, and by whom.

The data I analyse is primarily discursive. The discursive data is split into two categories, which I have termed "background" and "public". Background data includes informant elicited responses alongside field notes from conferences and other climate change meetings. Public data describes commentary intended for a public audience, and includes film, media reports, popular science books, institutional commentary and reports, environmental campaigning materials and policy documents.[46] The distinction between two data sets could potentially be categorised as published/unpublished. However, the terms "background" and "public" better describes the relational nature of the two sets of commentaries as understood in my research, wherein what is communicated to the public differs from perspectives voiced in more expert communities. I draw background data from first person accounts performed between knowledgeable audiences, predominantly interviews between the researcher and the actor in question. The conferences and other meetings which provide field notes for the background data, though not one-to-one situations, are again communicative acts performed for a relatively small but consistently knowledgeable audience. I compare these performances with public communications, that is communication to large audiences whose level of knowledge will vary significantly.[47] A further reason for using a "background/public" rather than "published/unpublished" distinction is that some of the public commentaries are radio and film broadcasts, which normally are not described as publications. The first part of this chapter explains the rationale for the data sets used, and the categories employed to structure the data. The second half of the chapter describes how the data was sourced, and the methodological techniques employed to analyse the data.

[46] I include policy documents in this category. Whilst not directly disseminated through broadcast channels, and written in a more formal language than is the case with the other commentaries, they are the product of a democratically accountable body and are freely available from the government, either by request or on the internet.

[47] For example a subject reading a report from a climate change campaign organization is presumably more informed than the subject reading a news report in the Daily Express newspaper, yet both are, for the purposes of my research, public commentaries. Though both are grouped into the one broad category of public commentaries, in my analysis I do compare across these different types of public communication.

5.2 Research strategy

The topic I am researching yields little directly or definitively measurable data in the sense that I cannot count or weigh the extent to which public two degree discourses are serving elite interests. I instead have to rely on interpretation of a large and diverse body of data, in order to cast as much light as possible on to these otherwise hidden agendas, and to ensure the highest possible standards of reliability for my interpretation of the evidence, and, therefore, findings.

5.2.1 Multiple method strategies

Bryman claims multi-method approaches are frequent in qualitative research (2007: 268). My review of the literature shows that such approaches are in fact essential in researching the social construction of environmental problems.

The construction of environmental problems is a diachronic, synchronic and multitudinous performance, involving a range of actors, a variety of sites, and an extended timeline. Wodak stresses that in instances such as these where there is an historical dimension to the research field, the researcher must be prepared to work inter-disciplinarily, multi-methodologically and on the basis of a variety of different empirical data (2008: 12). My research is characterised by a flexible and pragmatic attitude to methodology because my work, like that of Gillen and Petersen, is motivated by 'theoretical and political concerns, rather than a desire to use a method or particular methods' (2005: 149). Weingart, Engels and Pansegrau, in their analysis of how discourses on climate change in science, politics, and the mass media had influenced the position of climate change in the German political agenda, faced some of the methodological issues that are apparent in my research. The scientific discourse they sought to analyze '(took) place in an immense number of conferences and journal publications...making it almost impossible to represent an adequate picture' of these discourses (2000: 236). Their approach, in the face of this complexity, was to make a purposive sample of journals which were deemed to have had an influential role on the German political discourse which was then supported with interviews with German scientists (ibid).

5.2.2 Triangulation

Comparison across two or more distinct data sets is common in qualitative research. This distinction between different data sets, with one set of data being treated as 'background'

data, is directly echoed in Reisegel's account of how to source and organise discursive data (2008). Reisegel argues that a research structure which differentiates between background and other discourses not only allows for comparison between the two data sets but it also permits triangulation between the bodies of data. Triangulation can take many forms, and my research employs an approach termed 'between method triangulation' (Arksey and Knight, 1999: 23). This requires the collection of 'a variety of empirical data as well as background information with the help of a multiplicity of elicitation methods (for example observation, audiovisual data, interview, research in archives, recording and so on)' (Reisegel, 2008: 103-104). This process of triangulation is an important tool in addressing concerns about validity and bias in research (e.g. Arksey and Knight, 1999). As an example, I may compare claims in environmental campaign literature of a scientific consensus on the two degree dangerous limit with what climate scientists say on the issue in the interviews I conducted and at conferences I attended, combined with descriptions gleaned from the review of the academic literature. Implicit in this comparison is an assumption that what is said in interviews, academic papers and at conferences more accurately reflects the truth about the state of our knowledge about dangerous limits to climate change than may be found in public discourses. I understand these background sources as more accurate and trustworthy than public discourses because the latter are mediated through processes designed to meet ideological and other objectives.

Another comparison I wish to make is between different public outputs, such as print media, online media, TV documentaries, radio broadcasts and film. Fowler argues that the professional journalistic ethos demanding balance, accuracy and truthfulness is apparent across all media activity (1991: 1). Political economy theories of media discourses would suggest that all media output on a particular topic is likely to fulfil the same ideological function. Pluralist, organizational and cultural theories of news production on the other hand suggest that the reader would encounter variety in the treatment of a subject such as dangerous climate change. For example, a tabloid newspaper working with restricted resources and print space, reflecting the culturally defined interests of its audience, may not address the uncertainties surrounding the issue of the two degree dangerous limit in the same way as an in-depth feature on the topic in the science section of the BBC website, the latter having far fewer restrictions on space, and addressing a more interested audience. How does a one hour television documentary broadcast on BBC4 dealing with the history of the science of climate change address the two degree limit, if at all? A comparison across a variety of outputs such as this will show whether the theory that the way the two degree limit is reproduced is intended to support a common ideological position is tenable.

Triangulation across diverse data sets is a feature of Carvalho and Burgess' critical discourse analysis of climate change reporting. They suggest that using 'quantitative and discursive textual analyses on the multiplicity of print and broadcast texts' alongside 'ethnographic research with different audiences is extremely challenging, although vital if social constructions of risk are to be properly understood' (2005: 1460). Weingart, Engels and Pansegrau (2000) applied a three layered contextual approach to the comparison of differences in how climate change risk was communicated across three public institutions – science, policy and the mass media.

5.2.3 Defining the research goals

The difficulties of researching a process localised neither in space or time must figure in defining the goals of the research project. Wall, in his exploration of the methodological issues facing constructionist accounts of environmental issues, claimed that what is sought is not certain and definitive social explanations but 'recurring contingencies and causal tendencies which render some explanations more powerful, more saturated with meaning' (1999: 354). The goal of arriving at explanations saturated with as much meaning as possible requires not only a willingness to use a broad data set, but also the exploitation of more than one methodological approach. Though my research strategy is predominantly qualitative, some of the empirical data has quantitative properties which can aid understanding and explanation. Where such data is available I follow Pollack's injunction (2008: 82) and make use of that data. The timeline chapter of this thesis illustrates the value and legitimacy of using a multi-method, multi-strategy approach. If Corbett and Durfee are correct that **'**media reporting of science is tied to classic definitions of news and is often event driven, using the occasion of a scientific meeting or publication in a major scientific journal to spur attention to an issue' (2004: 131) then I can examine whether the frequency of the appearance of the two degree idea fluctuates in line with the events identified in the timeline. This is a quantitative analysis. I then deepen the analysis with the qualitative analysis of the media discourses identified. Such an analysis will be a useful aid to describing how representations in the media of the two degree limit have, or have not, varied overtime and to what extent media commentaries reflect the evolution of the two degree limit in scientific publications and conferences.

Another important decision is about depth versus breadth of analysis. The more texts analysed the less detailed the analysis offered. However, multiple data sets provide a more complete understanding by uncovering complexities and contradictions. Either choice, (breadth against depth), will involve the sacrifice of meaning. Though I do not attempt an explicitly inter-textual

analysis, an examination of texts from diverse sources will inevitably reveal interdependencies between texts in the resources they draw upon in the discussion of the two degree limit.

Different institutional and epistemic discourses are divided by indistinct and shifting boundaries (Lahsen, 2008; Martell, 1992). A comparison of a broad range of commentaries will reveal the shared assumptions that arise as a result of these porous boundaries. Different communities adopt the discourses of other groups and situations depending on the audience and context in which the discourses are produced. Lahsen provides the example of the interaction between media and science discourses, wherein it is not only a case of the media simplifying and popularizing science stories but scientists also seeking to influence media portrayal of science through use of popular metaphors and promotion of particular images (2007: 176).

5.3 Selecting the commentaries to be analysed

Table 4 lists potential sites for the construction of the dangerous limits consensus. The terms published and unpublished used in the table equate roughly, though not precisely, with the background/public dichotomy suggested above. At this point I want to distinguish between those commentaries that have gone through some form of editorial review prior to publication with what can be considered more informal discussions of the topic (unpublished). I have also ordered the sites in terms of proximity to the scientific source of the knowledge used in the construction of meaning, with the closest at the top, the furthest away at the bottom. This ordering is more applicable to the published sources than the unpublished. Not all of these sites are accessible to me, for example historic conversations within climate modelling communities. In such instances I use a combination of second hand accounts from the literature and informant elicited responses from actors who have either worked as part of these communities or researched how they work.

Other commentaries, such as email discussion lists are worthy of their own distinct research methods and strategies (Gruber, 2008) and are not part of the data set used in this thesis.

The categories listed in *Table 4* (below) are the ones we would expect to find, given the conclusions of existing research into the production of environmental knowledge, which shows scientific, political, media and campaign groups to be key communities in the framing of environmental problems under modernity (Longhino, 2002; Weingart, Engels and Pansegrau, 2000; Martell, 1994; Stocking and Holstein, 2009; Neuzil and Kovarik, 1996).

Table 4: Potential sites of construction for the two degree limit.

	Published	Unpublished
Science	Academic papers	Climate modelling communities
↓	Conference outputs	Conferences
	Science/policy documents	Workshops
	Policy documents	Meetings
	Environmental campaign statements	Conversation
Public	Mainstream media broadcasts	Public email discussion lists and other public forums

The boundaries between these discourses are often fuzzy, permeable and shifting. However, in order to compare the manner in which the idea of a two degree dangerous limit is produced in different settings, it is necessary to treat environmental campaigning organisations, the media, policy, science and policy/science actors as separate entities for the purpose of analysing the data. When discussing the findings it will be useful to investigate the extent to which these categories form distinct 'discourse communities' (Wodak, 2008: 15) in their treatment of the two degree limit, with discourse communities defined as 'ensembles of a set of storylines and frames, the actors that utter these and the practices that conform to these story lines' (Pettenger, 2007: 101).

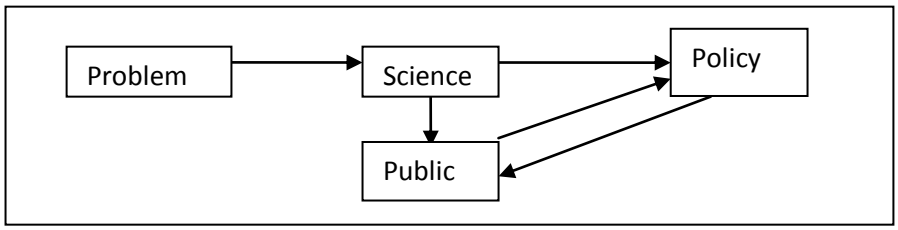
5.3.1 Information flows between the discourse communities

Rational instrumental models of communication depict a linear communication of science to the public as follows:

> Scientific research helps to discover an environmental problem; it identifies options for the problem's potential solution; scientists inform politicians of these findings; and, as political decision making can always be expected to suffer from some inertia or be distorted by interests that run counter to environmental concerns, scientists can also try to create public awareness to foment political pressure. Thus, the model's basic idea is that of information flow among these spheres (science, politics, public), and it assumes that, ideally, the content of the information passes on unchanged

> and initiates political action almost automatically, following the "rational logic" of the information obtained.
>
> Weingart, Engels and Pansegrau, 2000: 262

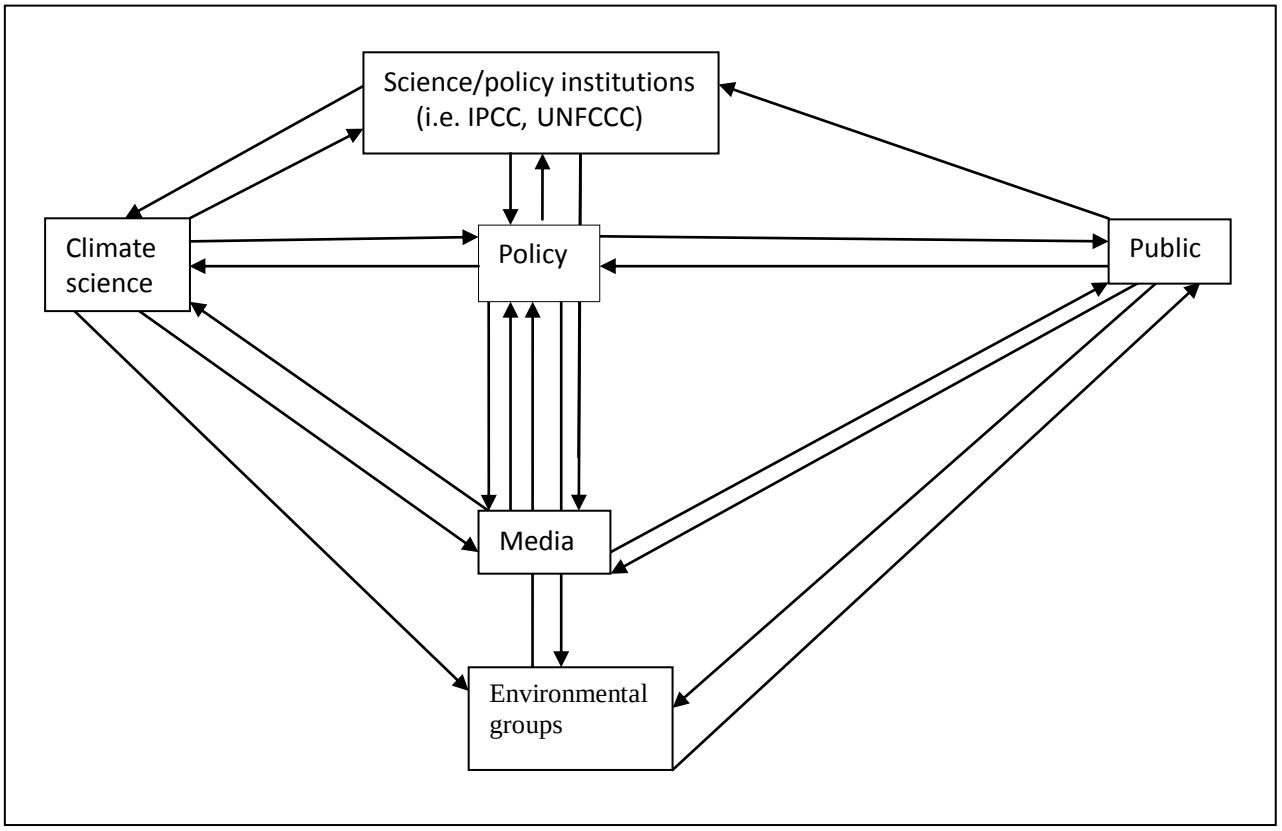
Figure 7: A rational instrumentalist model of communication for environmental problems.



Weingart et al., (2000) argue that the model shown in *Figure 7* does not accurately reflect the communication of information about environmental problems because it fails to take account of how the information is distorted and used differently in the communicative strategies of the various actors. Others have argued that the model does not reflect the extent to which political action is constrained by public opinion (Leiserowitz, 2006; IPPR, 2008), media discourses (Smith, 2005; Boykoff and Boykoff, 2004; Corbett and Durfee, 2004) and the actions of corporate lobby groups (Jacques, Dunlap and Freeman, 2008). Nor does the model account for the pre-existing cultural biases of different publics as discussed in the grid/group model. The rational communication model is further complicated if one accepts that it is virtually impossible to separate science and its use in policy when dealing with complex, uncertain systems (Kaiser, 2003: 41). *Figure 8* (below) outlines the key relationships in the flow of information and ideas between the different discourse communities examined in this thesis.

I now turn to a discussion of the relationships shown in *Figure 8* in more detail, beginning with the media.

Figure 8: The flow of discourses analysed in this research.



5.3.1.1 News Media

The media has direct connections with all other discourse communities in *Figure 8.* For most citizens, knowledge about science comes largely through mass media, not through scientific publications or direct involvement in science (Corbett and Durfee, 2004: 130; Kasperson et al., 1998: 18). The sources journalists use have also been shown to shape the media coverage of scientific issues (Antilla, 2005; Carvalho and Burgess, 2005).

I have included an arrow from media to climate science because the debate about the robustness of climate science at the Climate Research Unit at the University of East Anglia which arose at the end of 2009, alongside critiques of some projections in the IPCC 2007 Assessment Report, is an example of media reporting having the potential to influence the communication of climate science. The media, in not only shaping public risk perception but also articulating public opinion, are assumed to play an important role in policy making (Carvalho and Burgess, 2005: 1457). The media's gate keeping role not only works to exclude certain perspectives, but also ensures actors wishing to have their stories covered by the media present the narrative in line with journalistic norms (Smith, 2005). Koopmans' studies on the impact of the media on environmental movements saw the media not only as

influencing the opinions of lay audiences, but also as a crucial source of information for engaged communities on each other's views and behaviour, and that these communities 'evaluated and adapted their own strategies' in light of this knowledge (2004: 370).

5.3.1.2 Science/policy institutions

Climate science is communicated to policymakers directly (for example the Exeter conference on Dangerous Climate Change in 2005) and through hybrid policy/science bodies. In the UK these bodies include organisations such as the Committee on Climate Change whilst at the international level the primary body is the IPCC, whose reports includes summaries for policy makers. In the above communication model science/policy institutions are shown to communicate indirectly with the public via media and policy bodies, whilst being shaped by considerations of public welfare - the self-confessed goal of these institutions is to provide policy makers with the information needed to protect the public from dangerous climate change. The distinct position given to science/policy institutions in this model is not always apparent in the real world. As repeatedly stated in the literature and this thesis, climate change is a highly politicized science, as evidenced in the histories of the development of the IPCC provided by Agarawala (1999), Bonhmer–Christiansen (1994) and Bolin (2007). Despite the fuzzy and shifting boundaries between science/policy institutions, climate science and policy, the former institutions author their own analyses of the dangerous limits concept, and so these discourses are given separate treatment in this thesis. It is assumed that these discourses are, as with other narratives, sensitive to media norms.

5.3.1.3 Policy actors

Whilst the above accounts identify a central role for the media in the construction of climate change, Carvhallo and Burgess have argued that political actors have played by far the most powerful and effective role in shaping perceptions of climate change in the public sphere over the last twenty years (2005: 1478). This claim aligns with the elitist theory drawn upon in this research, which argues that political power stems in part from the ability to articulate and set the terms of a discourse (Roberts, 2004: 125). Such claims have to be measured against the potential for any particular political party to be influenced by the need to garner sufficient public support in elections, and the role environmental campaign groups and the media play in generating or undermining public support for environmental policy. Discussions of climate change communication which are grounded in pluralist theories argue that environmentalist

discourses have an influential role in setting the terms of the media debate (Smith, 2005; Doulton and Brown, 2000) and the policy agenda (IPPR, 2008). Policy is shown to influence climate science through the provision of funding for particular areas of research (Hansen, 2007).

5.3.1.4 Environmental campaign groups

The category "environmental campaign groups" elides significant differences in the organizational form of campaigning organisations.[48] The larger more established organizations such as the World Wildlife Fund, the Green Party and Friends of the Earth, in having a hierarchical structure differ in their organization from more informal, amorphous groups such as the "Climate Camp". However, in so much as all these organizations can be defined as 'a collective attempt to further a common interest or goal through collective action' (Martell, 1994: 108), there is sufficient commonality to treat these different groups as one discourse community. Environmental campaigners are reliant on the discourses of science in order to argue their case (Darier, 1999; Beck, 1995). These groups sometimes work with the climate science community to produce new research (for example Ockwell and Carter, 2007) though it is more common for campaigners to synthesise existing climate science alongside policy analysis in support of particular campaign objectives.

5.3.1.5 Public

Though the public feature in the communication model, public perceptions of the two degree limit are not analyzed because I have not been able to identify research on this topic in the literature (though there is research on public perceptions of climate change more generally) and so do not form part of the data set analyzed in this thesis. Nonetheless, the public are an important element of climate science communication.

5.4 Data sources

In this section I describe the data sources I will be analysing, and how I intend to structure that analysis. Breakdowns of actual numbers of texts identified are provided in Appendix 4.

[48] It has also been argued that, ideologically, green groups share little in common. Ross (1994) and Dobson (1990) identify a belief in the ecological limits of industrial activity to be the only unifying thread of green thought whilst others claim a shared assumption that environmental policy is secondary to the state's primary goal of securing the conditions for economic growth (for example Bello, 2008; Sanne, 2002; Schlosberg and Rinfret, 2008; Paterson, 1996; Barker, 2008).

Patton identifies three kinds of qualitative data; interviews, observations and documents (2002: 4). My research uses all three, and under the category of "documents" includes audio and audio-visual materials as well as written commentary. I operationalize the comparison process by drawing on Wodak's concept of context (2008: 12).

Figure 9: Layers of context.

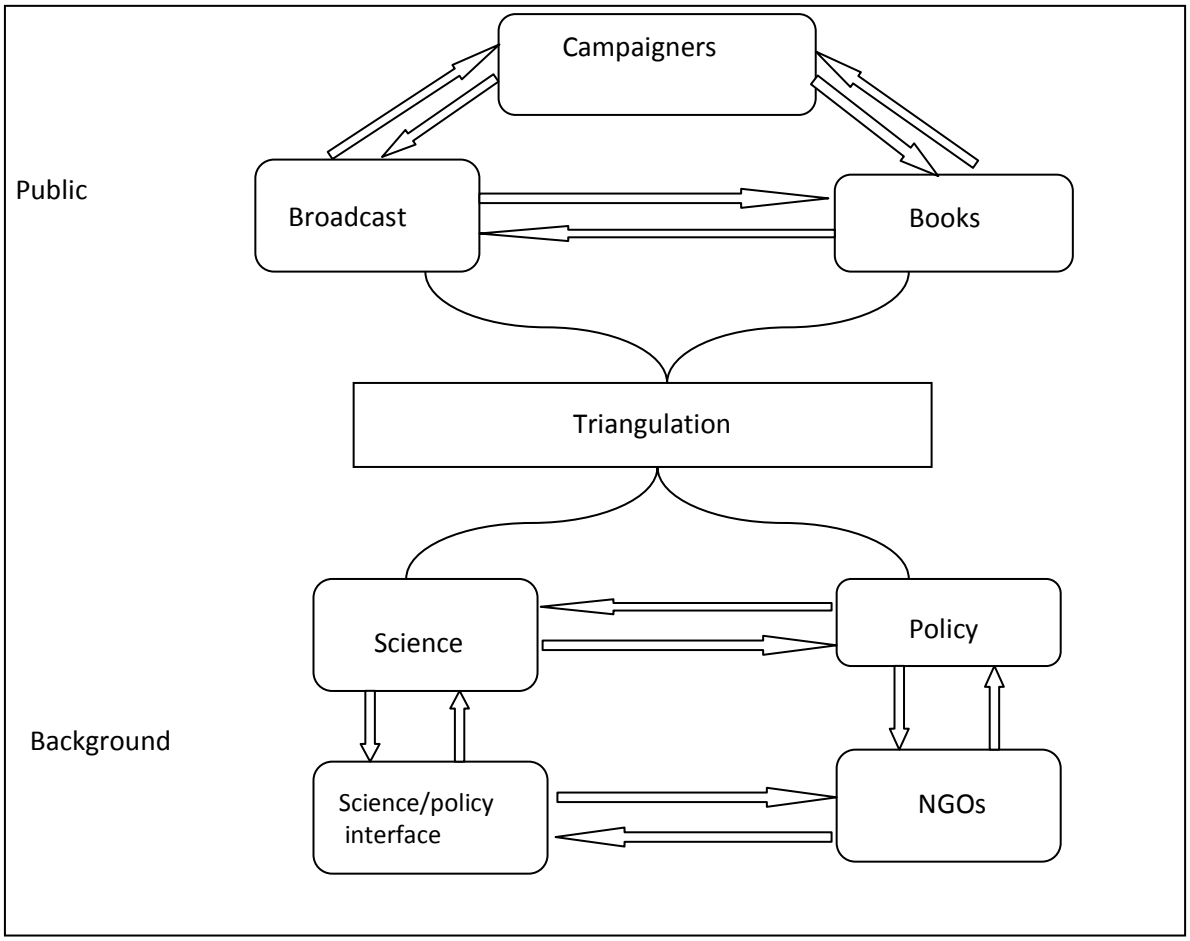


Figure 9 follows Wodak's schema for identifying different layers of context which she used to record 'the varying perceptions, selections and distortions of information' that constituted the '*recontextualisation* of an anti-Semitic...stereotyped image...which occurred in a particular Austrian public discourse of 1986' (2008: 13). Her research traced the reconstitution of this image, starting with original documents about particular wartime activities (the equivalent for me would be the original peer reviewed climate science papers) via various levels of mediation and commentary through to public discourses on the topic from the media and policy sources. The relevance of this study to my own research is in its building of discursive detail from the range of different, layered sources. The contextual approach I employ builds on the communication model above.

The arrows are used to indicate how the analysis of these discourses will seek to identify relevant relationships between the different discourse communities, whether in the form of differences or commonalities between the communities. The “broadcast” category is a collective term for mass audience communications.

I now move on to outline how primary and secondary data sources were used in my research, moving down through the model.

5.4.1 Public commentaries

These commentaries are communicative acts directed to a public audience and have some persistency in the public sphere.

There are some important differences between the textual characteristics of the public commentaries. In the instance of the newspaper stories, how the stories are laid out on the page, different text sizes and the use of imagery are not apparent in the copies of the articles stored in the Lexis-Nexis database.

Table 5: Level 1 data.

Source	*Sampling type*
Printed and online news media	Random/stratified
Audio news and commentary	Purposive
Film and documentary	Purposive
Books	Purposive/theoretical
Environmental campaign materials	Purposive

Articles from the BBC Online news service contain hyperlinks to other, related stories, as well as features such as quotes pulled out of the story and given prominence through the use of text boxes. Whilst analysis of these features would deepen understanding of how these texts perform communicative acts (Mautner, 2008) it is important, as much as possible, to standardise the analytical methods applied across my data sets. Thus, it is the words used in

the documentaries, audio broadcasts and books analysed in this thesis which constitute the data of interest.

Though my research indicates the number of documentaries, books and audio broadcasts featuring discussion of the two degree limit are relatively few, it is difficult to make robust claims about the representativeness of the book examples analysed here.[49] Despite this, the inclusion of book data means I am able to gauge to what extent the news articles, NGO statements and policy declarations are truly representative of public commentary on the two degree limit. If the books, documentaries and audio broadcasts included in my analysis analysed here construct the two degree limit using the same resources as those evident in the other secondary sources then I can be more confident about theoretical claims about the construction of public meanings of the two degree limit.

The sampling techniques used for the public sources other than news media is akin to what Bryman describes as 'theoretical sampling' (2007: 333-334). With theoretical sampling the selection of data sources is guided by theoretical considerations and is supposed to continue until a point of theoretical saturation is reached. In the case of this research this simply means searching through the data to find as many examples as one can, and until one can no longer find examples which further deepen or disconfirm the theoretical assumptions of the research.

5.4.2 Printed and online news media

In this category I analyze both newspaper articles and reports from the online BBC news service. Given my stated aims of trying to include data from as broad a range of sources as possible, I have included both tabloid and broadsheet newspapers in my analysis. Boykoff and Mansfield question the focus on broadsheet news sources in media analysis of environmental reporting. They note that the reason for this focus is the presumption that broadsheets are the primary influence on international and national policy discourse and decision making (2008: 17). Whilst not disagreeing with this perspective, the authors argue that in fact the majority of the newspaper reading public are reading tabloids. Tabloids differ from the broadsheets in their greater tendency to use opinion pieces, and to have less depth and breadth in their reporting (van Zoonen, 2004). The timeline chapter has shown that the tabloids feature fewer

[49] I am confident that the documentaries listed here approach something like the totality of English language documentaries featuring discussion of the two degree limit, as the total number of films and documentaries with climate change as their subject matter is relatively few. There is no search function for identifying television and radio news broadcasts which make mention of the two degree limit. This makes it difficult to know how representative the sources I identified are of the whole population. However, the difficulty I had in identifying any radio programmes dealing with the subject at the time of the Copenhagen conference, ostensibly called to agree the two degree target (and which my research shows received extensive coverage in the print media) indicates that coverage at other times would be scant.

mentions of the two degree limit. I will extend this to identify quantitative and qualitative differences between the broadsheets and tabloid news sources.

The Lexis-Nexis database was utilised to search across all major UK newspapers using the Boolean search term "two degrees" and "2 degrees". Both search terms produced the same results. Different newspapers have different start dates for their inclusion in the Lexis Nexis database. I wanted to extend the search back as far as possible, whilst still including the majority of UK newspaper titles[50]. This meant conducting searching from 30th October 2000, the date from which *Daily Telegraph* and *Sunday Telegraph* articles are available on the Lexis-Nexis database. These searches were carried out on 7th March 2010. I then searched through these articles to identify those where the "two degree" phrase referred to discussions of a limit to climate change.[51] I excluded letters to the editor as I was interested in the descriptions generated by the publications themselves. I included commentary pieces as well as news items. The initial search provided 1633 news articles which included the term "two degrees". After removing articles where the mention of "two degrees" was in reference to something other than dangerous climate change, or where the reference was made in a letter to the editor, I listed the articles from each title separately in date order, selecting every sixth article. This provided 301 newspaper articles for my analysis.

BBC online news items were identified by entering the "two degree" term into the search box on the BBC News website. The BBC search function doesn't provide any means of defining date parameters. To ensure the BBC articles were from the same date range as that used for the Lexis-Nexis search I first identified which of the BBC articles where the two degree phrase appeared were about the limit to climate change. I then excluded those which were from before 30th October 2000.

5.4.3 Books

Huntingford and Fowler identify popular science books as a significant element of the public discourse on climate change (2008: 1). Some popular science books will be more academic than others but all the books chosen for analysis were aimed at a public audience. Most were identified for analysis through a process of theoretical sampling. These were often books I had read initially out of general interest, rather than because they make reference to two degrees.

[50] The only ones not included were the smaller circulation papers such as the Daily Star and Morning Star.

[51] Often where the phrase "two degrees" appeared in a story about climate change it was not referring to the dangerous limit concept. Instead the phrase might be describing the fact that the weather for a particular time period might be two degrees warmer than the average for that period or may be a call to 'turn your thermostat down by two degrees to save the planet' (*Daily Mirror*, 17th February 2005).

Most of these titles I became aware of through reviews in the popular media, or discussion of the titles in online discussion forums. The books were read cover to cover and passages describing the two degree dangerous limit were copied into a Microsoft Word document which could then be analysed using the Atlas ti software.

5.4.4 Audio news and commentary

These broadcasts were identified through a combination of convenience and purposive sampling. Where I have been aware of such broadcasts, either through my own listening or because they have been highlighted through different internet and email forums, and where these broadcasts make reference to the two degree limit, I have used them. The BBC offers a service whereby one can access news radio broadcasts, in the form of podcasts, from the previous week. Through this facility I was able to analyse three relevant BBC news podcasts. In addition, through convenience sampling, I was also able to record commentary from three other BBC radio programmes, one a news broadcast, one a consumer affairs programme discussing the impacts of the Copenhagen Accord on consumers, and the third a science programme.

5.4.5 Film documentaries

Whilst it is not possible to quantify the population for English language documentaries addressing the two degree limit which have been broadcast through mainstream media channels, one can reasonably argue that the population is a small one, and likely in single figures. I have identified two documentaries commissioned by the BBC. One was a three part series documenting the history of climate change science, broadcast on BBC2 in December 2009. The other was a one-off, one hour documentary called Hot Planet, broadcast on BBC1 on 9th December 2009, which examined what impacts were likely at different levels of warming. My sample also includes the 2006 documentary film by Al Gore, An Inconvenient Truth, and the 2009 drama documentary The Age of Stupid.

I analyse only the verbal element of these texts, so that the data can be compared with the data from other sources. I analyse only those elements which directly address the two degree limit. This involved watching the documentaries all the way through, copying down passages which mention two degrees into Microsoft Word, and then analysing the data with Atlas ti.

5.4.6 Environmental campaign commentaries

A process of purposive sampling was used to collate a wide range of examples of UK and international environmental discourses featuring description of the two degree limit, where those documents have been intended for public consumption. Twenty statements on the two degree discourse have been analysed. These were largely sourced online, either from the organisations main website, or from reports published by these organisations. I also include pamphlets and promotional materials sourced from talks, protests and events I attended as part of my field work.

5.4.7 Triangulation of public and background commentaries

The analysis of the public data will be triangulated against the background data. This process of triangulation is intended to reveal the extent to which the climate science, science/policy documents and informal understandings of actors from the background discourse communities differ from the descriptions of dangerous climate change provided in the public discourses. This analysis is used to reveal what gets changed and distorted through the process of mediating discussion of the two degree limit, as well as providing 'a socio-historical context' (Wodak, 2008: 31) for the way these public discourses are constructed.

5.5 Background data

The background data is predominantly drawn from primary sources, in the form of interviews and observations/field work. The observation/field work category includes data derived from the recording of public, spoken communicative acts such as presentations and informal conversational settings. By contrast, the informant elicited responses are sourced from formal interview situations and other semi-structured communicative acts.

Table 6: Background data sources.

Discourse community	*Primary or secondary sources*	*Sampling type*
Climate science	Primary	Convenience/purposive
Science/policy interface	Primary/secondary	Convenience/purposive
Environmental campaigners	Primary	Purposive/convenience
Policy	Primary/secondary	Purposive/convenience

5.5.1 Informant elicited responses

Three separate approaches were used to elicit responses from informants; face–to–face semi-structured interviews; semi-structured telephone interviews; and email question and answer dialogues. Whilst it was my desire to conduct all interviews in person, issues of travel, expense, and availability of the interviewee meant this was not always possible. In addition, given the contextual purpose this information was designed to serve, to triangulate against the secondary discourses being analyzed, it was not obvious that the difficulties of achieving an in person interview would be outweighed by the advantages. Lowe and Lorenzoni, in discussing their interviewing of climate scientists and other experts on notions of dangerous climate change, are ambivalent about the disadvantages of using the telephone for some interviews. They recognise that in some circumstances the lack of personal contact may have affected the depth and breadth of the discussion, but for many respondents that was the preferred form of contact (2005: 50).

A combination of convenience, snowball and purposive sampling were used to identify informants. Bryman describes a convenience sample as one available to the researcher simply by virtue of its accessibility (2007: 100), and is an approach often used in conjunction with snowball sampling (304). These sampling techniques were secondary to the initial process of purposive sampling, which is the approach that Bryman considers to be most commonly recommended for generating qualitative interview data (2007: 333). Purposive sampling involves identifying people who are relevant to the research questions (Bryman, 2007: 333-334).

Part of my strategy, for example when trying to interview climate scientists and other academics working in the policy-science fields, was to purposively identify key informants on the basis of the literature and my experience. Where these advances were successful I asked these informants to nominate other individuals who they felt might be able to help me in my research. In other instances, such as when trying to interview activists at Climate Camp, I relied much more on convenience sampling, trying to find actors willing to speak to me. However, this convenience sampling was rooted in theoretical sampling, having selected the climate camp as a place where I may find actors able to build my understanding of how the two degree limit is interpreted by actors with a deep green perspective.

Lowe and Lorenzoni highlight the possibility that selecting interviewees through a combination of theoretical and snowball sampling could lead to an unrepresentative sample of ‘group thinkers’, with respondents recommending others with whom they have close contacts and a shared world view. Lowe and Lorenzoni conclude that in fact such concerns are unjustified,

that such an approach is a common one because it yields both diversity and informed opinion (2005: 30).

Bryman, whilst recognising the required number of interviews in any piece of qualitative research will essentially depend on the uses to which the data is being put, argues that for a qualitative study to be publishable the minimum number of interviews required, where respondents have been recruited through theoretical sampling, seems to be between twenty and thirty (2004: 334). I interviewed twenty seven actors, which is line with Lowe and Lorenzoni's examination of expert attitudes to dangerous climate change, which used data from twenty three interviews (2005: 56).

Interviews took place in two tranches. Initial interviews and observations were conducted between June 2007 and September 2008. There was a gap of approximately 3 months after completing this first tranche before I began transcribing these interviews and observations. A combination of transcribing the interviews, doing more reading for the literature review, and the ongoing process of reflection on my readings and research, caused me to feel dissatisfied with some of the interviews I had conducted. This dissatisfaction was a product both of some of the individuals selected for interview not being knowledgeable or senior enough to advance my understanding, plus a sense that my questioning had sometimes failed to focus on the relevant details. These issues were largely a product of the social nature of the interview situation. There is often a power differential between interviewer and interviewee. Whilst social research involving an academic researcher and the public might see the middle–class, well educated academic as the more powerful actor, this was not the case in my research. As a PhD student, approaching established scientists and academics with questions which sought to provide evidence for a theoretical challenge to an established tenet of the climate change debate, I felt nervous going into interview situations. I also felt that I was to some extent using the interview situation to seek approval for my ideas. Whilst I do not think these factors profoundly affected the quality of the interview data, when transcribing the interviews I sensed the interactions were to some extent coloured by this trepidation on my behalf. After attending and speaking at conferences, talking to prominent actors, and as a consequence of the feedback and comments I received from interviewees I developed confidence in the ideas I was researching, and consequently decided to secure some more interviews. This time I approached more senior respondents, and secured another twelve interviews during 2009. I transcribed each interview before conducting the next interview. This allowed me to become familiar with the data and use that familiarity to inform my questioning for subsequent interviews. Interviews range in length from fifteen minutes to over an hour. Questions dealt with issues about the history of the development of the two degree limit, the respondents

own personal understanding of why a two degree limit is used, and their experience of the two degree limit in shaping climate research and policy.

In the following section I detail how the informants were selected, including descriptions of the places and conditions in which the informants were identified.

5.6 Sourcing the respondents

5.6.1 Climate Camp, Heathrow, 2007

Climate Camp is the name given to a decentralized community of activists and campaigners who, very broadly, are aligned with anarchist politics and believe in the validity of direct action. The 2007 action was intended to use protests against the proposed expansion of Heathrow Airport as a focus for broader discussions about climate change policy. The camp was a week-long protest sited on illegally occupied land directly neighbouring Heathrow Airport and was attended by approximately 1,000 people. There was a strong police presence which undertook extensive body searches of everyone entering and leaving the camp. There was also constant surveillance by cameras and floodlights placed around the perimeter of the camp and continuous helicopter surveillance. In addition there was high media interest, but only a very few journalists were allowed onto the site, and then only if accompanied by camp representatives. These conditions impacted greatly on my attempt to record interviews with activists.

I attended the camp because I felt that it was here that I was likely to encounter actors with a radical/deep green perspective on climate change, and I wanted to find out how the two degree limit was interpreted by these actors. I stayed at the camp for four days and three nights. Data from the camp took three forms: field notes, semi-structured interviews and recordings of speeches and presentations. The field notes provided a useful aide memoir for the issues I faced in trying to arrange interviews and record presentations. I took two approaches to securing interviews. One involved putting up messages around the camp outlining my research agenda, my desire to interview activists and my mobile number for people to ring if they were interested. This yielded two responses. One of the respondents was able to introduce me to a friend who was also willing to be interviewed.

The other approach I used was to start up conversations with various camp attendees and where I felt some rapport was achieved, then asking if I could record an interview with the person. This worked in only one instance, with the co-ordinator of a climate campaign organisation. In all other instances the reaction was quite hostile, and there was a strong

aversion to being party to a recorded interview. Given what was previously said about the strong police presence and the desire to keep the media out of the camp, this was perhaps inevitable. One consequence of these abortive attempts at securing interviews was to cause some reflection on the potentially parasitical nature of my request, a danger which can only be avoided by a long-standing and partisan involvement with those one wishes to interview (Willig and Drury, 2004).

One other informant from the climate camp agreed to an interview. This individual had been working as one of the communication officers for the camp and wanted to follow up with camp attendees to garner feedback on people's experience of the camp, with the objective of using the information to ensure the next camp was more open and inviting to new audiences. She made contact through an email list after the camp had finished, and agreed to an interview in return for being able to interview me. This interview lasted for approximately an hour, and was recorded in Brighton.

Interviews lasted between twenty minutes and an hour, and were recorded using a small digital Dictaphone.

5.6.2 Conferences

I attended four conferences on the subject of climate change, all of which yielded useable observational data (see next section), and three of which provided interview opportunities.

i) British Sociological Association, Nature and Society. University of Warwick, April 2007

One of the speakers at the conference had co-authored a piece of climate change research which seemed closely aligned with my own interests and, given his extensive research record in the area of science and society, I was keen to secure an interview with him. This academic agreed to an interview, which took place by telephone approximately two months after the conference. None of the other speakers there were dealing with topics relevant to my research.

ii) An End to History? Climate Change, the Past and the Future. Birmingham, April 2008

This humanities-based conference indirectly yielded two interview opportunities. One of the delegates was Professor Mike Hulme, Professor of Climate Change in the School of Environmental Sciences at the University of East Anglia. Having spoken to Professor Hulme at the conference, I then emailed him to request an interview. He declined, on the basis that he

receives many requests for interviews. However, he was able to set up telephone interviews with two members of the staff at the University of East Anglia who he felt would be able to help with my research.

iii) Dangerous rates of change. Exeter University, September 2008

At this conference I was in the audience for a presentation by Professor Kevin Anderson, on the need to mitigate for two degrees of warming whilst developing adaptation policies on the assumption of four degrees of warming. The presentation made mention of the difficulties in defining two degrees of warming as a dangerous limit so I approached Professor Anderson to arrange a telephone interview for a later date, to which he agreed. I also was able to agree arrange a telephone interview with a senior member of the Meteorological Office's climate change communications team. I exchanged contact details with four other delegates, but subsequent email approaches to these delegates received no reply.

iv) 4 degrees and beyond: Implications of a global climate change of 4 degrees + for people, ecosystems, and the earth-system. Oxford University, September 2009.

This conference yielded one interview opportunity, with a climate change campaigner for Friends of the Earth. This interview took place at the conference, in the dining hall at lunch time. The timing and location of the interview meant the conditions were difficult (noisy, rushed and lack of privacy).

I now discuss how other interviews were secured.

5.6.3 Scientists

The general approach to eliciting responses from climate scientists has been to purposively sample the most senior actors. "Most senior" has generally been defined as those most senior within climate science organisations, or who are frequently quoted in the press or cited in the literature. Sometimes I have approached scientists who have authored papers which deal with the idea of dangerous limits. Snowball sampling has also been a feature of the selection process.

Having identified the WBGU reports as key markers in the two degree debate I was keen to speak to speak to the authors. An initial email to the office of the German Advisory Council on Global Change in 2008 had not been replied to. In February 2010 I emailed Professor

Schellenhuber, the director of the programme, directly. I received a reply from one of his assistants advising that he would be able to spare 30 minutes on the telephone. This offer was retracted the next day, the reason given being the pressures on Professor Schellenhuber's time. I assumed that it would not be possible to secure an interview with anyone from the WBGU but two days later I received an email from the deputy director of the organisation and a co-author of the WBGU papers who agreed to a telephone interview. This interviewee introduced me to another significant academic and co-author of several IPCC reports.

I also identified another IPCC author who had published papers on the topic of values in defining dangerous climate change. This scientist was available for a telephone interview and also introduced me to a senior member of the WWF climate campaign team.

In total nine climate scientists were interviewed from 17 approached. All interviews were conducted by telephone.

5.6.4 Environmental campaigners

It has proved difficult to get interviews with senior members of environmental and climate change campaigning organisations. Either my approaches have received no response or commonly where a reply was received it was to be told that the charitable and publicly funded nature of these bodies meant it was not considered a valid use of the staff's time to engage in such interviews. This has made me more reliant on convenience sampling than purposive sampling. Some of the interviewees were identified through involvement in email discussion lists, others as contacts built up through campaigning activity. Overall I secured interviews with thirteen campaigners. Seven of the interviews were face to face, three via email and three via telephone.

5.6.5 Science/policy actors

The distinction between these category and that of scientists is somewhat fuzzy. It predominantly includes academics working on climate change issues who are not climate scientists. Of the four informant responses I have been able to elicit, three came from contacts made at the four conferences listed above, and one through an introduction made by one of my PhD supervisors.

5.6.6 Policy actors

The policy discourse community proved an almost impossible body from which to source informant elicited data. All attempts at securing interviews with members of parliament with responsibility for climate policy were unsuccessful. Either I received no reply or was told the person in question did not have the time to be interviewed. It has therefore been necessary to rely on the secondary policy statement sources as a window into policy thinking on the two degree limit. In some senses this does not represent a significant lacuna in the data as it is difficult to imagine any individual politician deviating markedly from the policy line. However, it was possible to secure an interview with an MEP from the Green Party. This required me to volunteer some time working on a stall handing out information on the Green Party.

5.6.7 Journalists

On two occasions, February 2008 and then again in February 2010 I emailed several environmental journalists requesting an interview. I received no replies from the first attempt, and one reply on the second attempt, from Roger Harribin, the BBC's environment analyst, who agreed to answer some questions by email.[52]

During the first tranche of interviews I stuck quite rigidly to the pre-prepared questions. The questions varied slightly according to the discourse community represented by the actor but did not vary tremendously in relation to the responses received. During the second tranche I allowed myself to follow the flow of the conversation more freely, chasing up lines of enquiry that developed during the interview or returning to a question where I thought an answer wasn't providing all the information I was looking for.

The email exchanges which I include here as informant elicited responses have a different dynamic from the face to face and telephone interviews, not least in that the respondent is able to compose an answer prior to replying. An interesting hybrid of email and telephone interaction occurred when interviewing an American climate scientist who asked to see the questions prior to the telephone call. This resulted in a non-stop one way conversation from the scientist to me which lasted for approximately 30 minutes, after which there were no questions left to ask.

[52] When researching contact details for the daily Telegraph's environment correspondent, Geoffrey Lean, I came across a statement on the Telegraph's website explaining that they have a policy of not allowing their journalists to be interviewed by research students. Whilst I did not find any such statement on any of the other news websites, it is possible that this is a widely shared prohibition.

5.7 Observations/field notes

This data set includes commentary drawn from presentations discussing the two degree concept. Mostly these are in the form of recordings made personally at conferences and events I have attended, but I have also included recordings from presentations which are available on the internet that I did not attend in person. Whilst there is nothing obviously skewed in my selection of presentations it is difficult to know how representative of these presentations are of all presentations discussing the two degree limit. However, they are sourced from a broad range of contexts, from the Climate Camp through to professorial lectures delivered at Cambridge University. These sources, by broadening the range of two degree discourses which are used to triangulate the public discourses, constitute a valuable contribution to the data set used in this research.

I have also included here comments that have arisen in conversation at various events which have seemed very prescient and useful to include as exemplars of more informal perspectives on the two degree limit. These have not been recorded but were written down in my field notes journal as soon as possible after the event in question.

5.8 Ethics

There are three main areas of the data collection that have raised questions about research ethics. One is the recording of presentations and workshops at the Climate Camp. The second is the inclusion of comments made in informal conversations as data. The third regards keeping informant details anonymous.

i) Climate camp observations

The act of being at the camp was an illegal act of trespass, but this fact does not raise the sort of ethical issues which impact directly on my research. The relevant ethical issue was my covert recording of workshops and presentations. As mentioned previously there was an embargo on media activity at the camp, with only limited access available to a few journalists, and only if they were accompanied. The reason for this is that the organisers of the camp assumed the mainstream media to be hostile to the aims of the camp and would be there only to undermine the aims of the action and the legitimacy of the movement. This meant my requests to record presentations and workshops were rejected. The first time I attempted to record a workshop (on anarchism and climate change) I asked the convenor if it would be ok for me to record what was said using my Dictaphone. The convenor put my request to the vote

of those attending the workshop and my request was refused, with several people leaving the marquee in anger at my request.

I felt that this attitude was understandable in the circumstances. I did not see how I could convince anyone that my intentions were benign and that I was not an undercover journalist or security official. I therefore had instead to rely instead on making notes in my field journal.

ii) Conversation

There are three occasions where in informal discussion mention of my research interests have garnered noteworthy responses. One occasion was in conversation with someone who was previously an assistant in the environment department of the New Labour government. His comments on the issue provided a useful insight into perspectives on the two degree limit within that section of government. On another occasion I was discussing my research with a friend who works for Friends of the Earth, but not on the climate change issue. Her comments were a useful indicator of how concerned actors who have not studied the issue in depth might understand the two degree limit. The third example was another informal situation, over dinner at a conference, where an Oxfam communications officer discussed his understanding of why Oxfam used the two degree target.

The ethical issue here is that the people in question did not and do not know that I have decided to use what they have said as data in this thesis. Once again, the fact that there comments are treated anonymously circumvents any significant ethical difficulties with use of these comments.

iii) Anonymous sources

During the first tranche of interviews I was not clear whether or not I would treat the responses anonymously. My overall aim was to name the actors where possible, and make anonymous those responses where requested to do so by interviewees. In discussion with interviewees it became apparent that the desire of the respondent to remain anonymous varied from actor to actor and also on the basis of what elements of the interviews I intended to use and how. By the time I approached the second tranche of interviews I had decided to make clear that all responses would be anonymous.

5.9 Critical discourse analysis

Different groups of actors attempt, through discourse, to construct more or less differing accounts of the gravity of climate change. I understand discourse as something of a battleground, where different actors and groups compete to have their definitions and constructions dominate the knowledge production process. The exercise of power is closely tied to production of knowledge; 'discourses represent what it is possible to speak at a given moment' (Ramanzanglo, 1993: 19). My discourse analysis of these discourses is intended to reveal the strategies employed in the production of knowledge about dangerous limits to climate change. Because I theorise that the dominant discourses on climate change are primarily designed to reproduce existing social relations, I turn to the techniques of Critical Discourse Analysis (CDA). CDA has been described as a contested research instrument with no blueprints for how to proceed (Chouliaraki and Fairclough, 1999: 23). However, there are some common assumptions underlying the decision to examine the social world through the lens of CDA. The aim of using CDA is to uncover the 'implicit or taken-for-granted values, assumptions, and origins of a seemingly neutral, self-evident, and objective...text, and relate it to structures of dominance and power' (Oulasson, 2009: 424). From this perspective texts are not passive but instead are seen as "work", part of productive activity and the process of producing social life. CDA is particularly relevant to my area of study, given its value in helping to reveal how language figures in responding to the 'detrimental environmental impacts of the neo-liberal global order' (Fairclough, 2001: 230). Importantly, given the connection I make between the quantification of climate change and the legitimation of modernity, CDA recognises that discourses are systems of knowledge which inform the technologies which consolidate power in modern society (Fairclough, 2001: 232). Oluasson justifies using CDA to analyse media treatment of climate change because its constructionist, socio-cognitive, and critical epistemological pillars harmonize well with the theoretical frameworks on which his research was based (2009: 424). In common with my thesis, Oluasson identifies CDA as the appropriate analytical tool for examining how, in late modernity, discourse naturalizes and maintains relations of power and dominance, makes them part of the natural order of things (Fairclough, 2001). I systematically apply these techniques across all my data, to understand the common discursive resources and patterns present in discussion of the two degree limit.

I understand a text to be the form in which a genre may be expressed, for example a newspaper article, book or television programme (Wodak, 2008). Entman argues for a frame analysis of texts as a means of operationalizing research theories (1993: 52). Frames are identified by 'the presence or absence of certain keywords, stock phrases, stereotyped images,

sources of information and sentences that provide thematically reinforcing clusters of facts or judgments' (ibid).

5.10 Units of analysis

Whilst frame theory has been successfully used to analyse commentary on climate change (Oluasson, 2009) because I am focusing on small passages, rather than whole text analysis I instead employ elements of Dryzek's approach to examination of environmental discourses. Dryzek defines four structural elements which he uses to define each of the environmental discourses in more detail. They are: 1) basic entities whose existence is recognized or constructed, 2) assumptions about natural relationships, 3) agents and their motives, and 4) key metaphors and other rhetorical devices (Dryzek, 1997). Following Mautner, I group these elements together into the concept of transivity, which asks 'How are events described, who does what to whom, who are the key actors in the narrative' (2008: 41). Transivity is one of the three frames Mautner suggests should be employed for the analysis of newspaper texts. The second frame is 'modality' which refers to the 'ways in which language is used to encode meanings such as degrees of certainty and commitment, or alternatively vagueness and lack of commitment, personal beliefs versus generally accepted or taken for granted knowledge (2008: 41). The third is 'whole text analysis' which I do not use because some of the documents, such as books and films, are too long, and make too fleeting a reference to the two degree limit to justify a whole text analysis.

In the absence of an established, uniform CDA methodology, the main instruments for testing the validity and reliability of its results are the 'logic and credibility of argumentation, backed up by quotes from the texts' (Carvalho and Burgess, 2005: 1461). As mentioned at the beginning of this chapter, given the complexity of the social world being investigated, I do not aim for a definitive statement of universal truth, but instead wish to increase our understanding of the social processes in question. Logic and credibility are key determinants of establishing claims to have increased our understanding.

5.11 Coding

I loaded the relevant passages from Microsoft Word into Atlas ti for coding. Codes were identified from the data itself and the theoretical perspectives employed in my research. I went through each passage in Atlas ti, identifying where two degrees was mentioned, and then analysing the sentence it appeared in and the relevant surrounding sentences. These

surrounding sentences would provide the context for discussing the two degree limit - why was it being mentioned, by whom, how credibly the idea was treated, what counter arguments were voiced etc. These passages were broken down into the appropriate quotes, as defined by the transivity and modality frameworks I employed. I developed the codes by attaching these quotes to what seemed the most appropriate code, and creating new codes where none of the existing ones were suitable. After the first attempt at analysing the whole data set I realised I had too many codes, and that some of the codes being used were in effect duplicates. This meant it was necessary to go back through the list of codes, and the quotes they related to, and amalgamating them into fewer, larger code categories. This process of revisiting the coding system made me very familiar with the data, and forced me to adopt a reflective and iterative process to the defining of codes and the relevant quotes. Where mention of the two degree limit appeared more than once in a particular text I coded each separate instance, to understand whether the concept was framed in a consistent manner within each text.

Prior to beginning the coding of my data I undertook a pilot study of one newspaper item. This exercise had two objectives. Firstly, the pilot study sensitized me to the themes and frames likely to be encountered in my analysis of public discourses. Secondly, I received feedback from my supervisors on this coding exercise which guided my coding of my data set. My pilot study used a shared editorial printed in 56 major newspapers in 45 countries. This was a commentary piece imploring the political representatives attending the Copenhagen Conference in December 2009 to agree a deal to limit warming to two degrees centigrade. The prominence with which a diverse range of European newspapers carried this message likely means the values and assumptions of the text reflects the ideology of a significant proportion of European media businesses. The message would have been read by a large number of people and so it seems reasonable to argue that the article must in some sense be constitutive of public meanings of dangerous climate change.

Where it is appropriate and informative to do so, I aggregate perspectives from a particular epistemic community, as articulated through a number of channels. For example, the opinion of campaigners on a specific aspect of the dangerous limit debate may be present across news reports, NGO websites, and in interviews. Comparison of commonalities and differences in how opinions are expressed through these various channels can deepen understanding of the factors shaping the construction of the two degree concept.

However, this flexibility in approaches to the analysis requires a formal approach to the coding of the data. This structuring will provide a basic foundation to the data which I can return to throughout the analysis, and which will form the basis of the narrative thread. The terms used, and their meaning, are as follows:

- Document families – the data source, i.e. news reports, policy documents etc.
- Code families – this is the largest aggregation of codes and is the framework for a tripartite division of the analysis. The code families are i) actors and events, ii) the two degree limit and iii) dealing with uncertainty.
- Code categories – each code family is made up of separate code categories. Code categories are amalgamations of individual codes into larger thematic groups. For example, the code category "Events" is made up of individual codes referring to data on the topic of the Copenhagen Conference, the 2003 European heat wave, G8 summits etc.
- Codes – codes are thematic groupings of quotes.
- Quotes – quotes are the actual segments of text attached to a code, and are the smallest unit of analysis. Quotes vary in size from just three or four words to four or more sentences. The actual length of a quote will vary according to context and meaning.

Making distinctions between code families and, to a lesser extent, code categories, has not always been straightforward. The "Dealing with uncertainty" code family provides a typical example of this difficulty. News reports frequently feature quotes from experts on complex climate issues. These quotes commonly circumvent discussion of the uncertainties present in the findings or current state of knowledge. Because of this, I have attributed such quotes to the 'Dealing with uncertainty' code category. However, I am also interested in examining what actors are quoted or named in discussion of the two degree limit. Is there a reliance on the opinions of elite actors and to what extent are scientists given the final word on defining dangerous climate change? Therefore some of the quotes from experts I have attributed to the "Dealing with uncertainty" reappear in the "Actors" code category. Where this occurs the quote is counted each time.

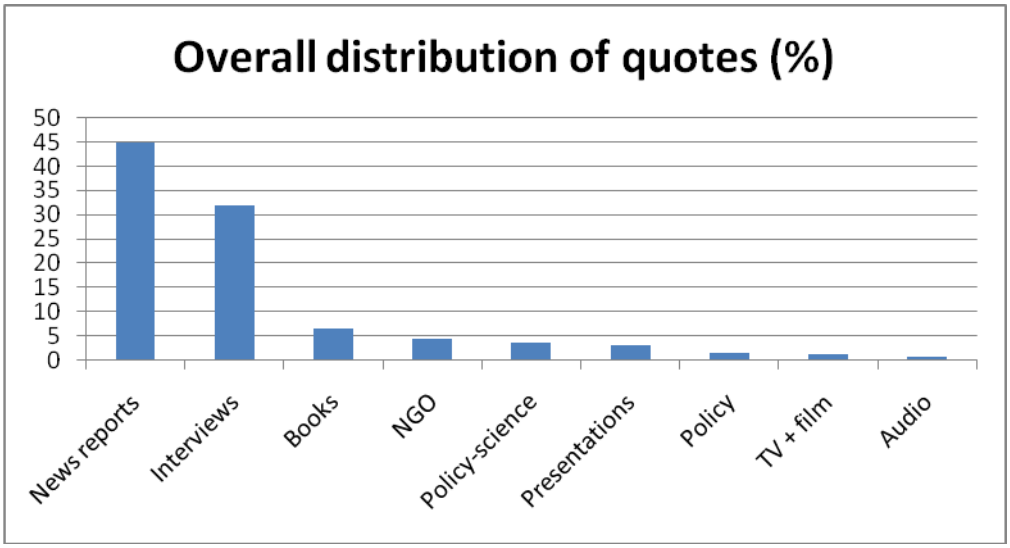
Table 7: Number of quotes in each document family.

Document family	*Number of quotes*
News reports	803
Interviews	569
Books	121
NGO	79
Policy/science	65
Presentations	55
Policy	24
TV and film	23
Audio	10

5.12 Approaches to the analysis

Table 7 shows that most of the quotes I am coding come from the newspaper document family, whilst the audio document family provides the least number of quotes for coding. *Figure 10* (below) represents these numbers as percentages of the total.

Figure 10: Distribution of quotes across the document families



Forty five percent of all the quotes I am coding come from the newspaper document family, 0.56% come from the audio document family. If there was no particular bias in the way in which commentaries from any particular document described the two degree limit, then I would expect the number of quotes for each code to follow the distribution of quotes

displayed in *Figure 10*. For the majority of the code categories I analyse in the next section[53], I begin by comparing the distribution of the quotes for that code category with the distribution shown in *Figure 10.* The purpose of this comparison is to identify any notable variation from the overall distribution for any particular code category. This quantitative introduction to the distribution of each code is then followed by an in-depth qualitative analysis of the codes. Close textual analysis is employed to compare patterns of transivity and modality across and within the document families.

The following data analysis is broken down into three chapters. Chapter 6 primarily addresses the data in terms of transivity, and examines the key actors and events invoked in discussion of the two degree limit. Chapter 7 is more concerned with modality, and compares how the different document families describe the dangerous limit. Is there agreement that two degrees of warming is the dangerous limit, or is the notion of such a clear distinction between safety and danger questioned. Chapter 8, again looking at modality, examines how uncertainty in projecting dangerous limits is handled.

[53] Not all code categories will have a sufficient number of quotes to make any quantitative analysis meaningful or reliable.

Chapter 6

Data analysis - Key Actors and Events

6.1 Introduction

This chapter describes the actors and events invoked in discussion of the two degree limit. "Actor" is used to describe the various social categories, organizations and individuals mentioned in discussion of the two degree limit (see *Table 8* below). "Events" here has both a social and physical meaning, treated separately. Social events are key conferences and reports dealing with the subject of dangerous climate change. Physical events are extreme weather events which feature in discussion of dangerous limits.[54] The following two chapters of this analysis will deal with what aspects of climate change are described as indicating that two degrees of warming is a dangerous limit and, in the third chapter, how uncertainties in projections of future climate change are addressed in the data.

Table 8: Institution, events and actors code categories and quotes. [55]

Code Categories	*Number of quotes*
Institutions	120
Events	103
Political leaders	87
Campaigners	38
Experts[56]	44
Public	8
Media	5

The purpose of this first chapter of the analysis is to describe how the actors and events identified are used as catalysts for discussion of the two degree limit, or are used to justify a particular position on the dangerous limits discourse.

[54] As a number of studies have already concluded, media coverage of the environment is dependent on events. Without any concrete incident that can be connected to environmental issues, it is highly unlikely that the media will report on, for instance, climate change (Oluasson, 2009: 426). Events covered here include those dealing with mitigation (i.e. conferences) and adaptation (i.e. the 2003 European heat wave).

[55] Perhaps surprisingly, there were very few mentions of industry as an important actor shaping the two degree debate. What mentions of industry there were saw the role of industry as negative. One campaigner, interviewed in the *Mail on Sunday* after the Copenhagen summit, pinned what he saw as the failure of the summit at the feet of industry: 'What we have actually seen over the last two weeks is raw industrial power at its worst, both on the part of China and the US and other countries' (December 20th 2009). In 2007 *The Independent* ran a series of articles on the subject of climate change sponsored and co-authored by the bank HSBC. In one of these articles the claim was made 'The growing consensus is that we'll only be able to cope if we can keep the warming to 2C. After that point, dangerous, even unstoppable, climate change becomes more and more likely' (December 1st, 2007).

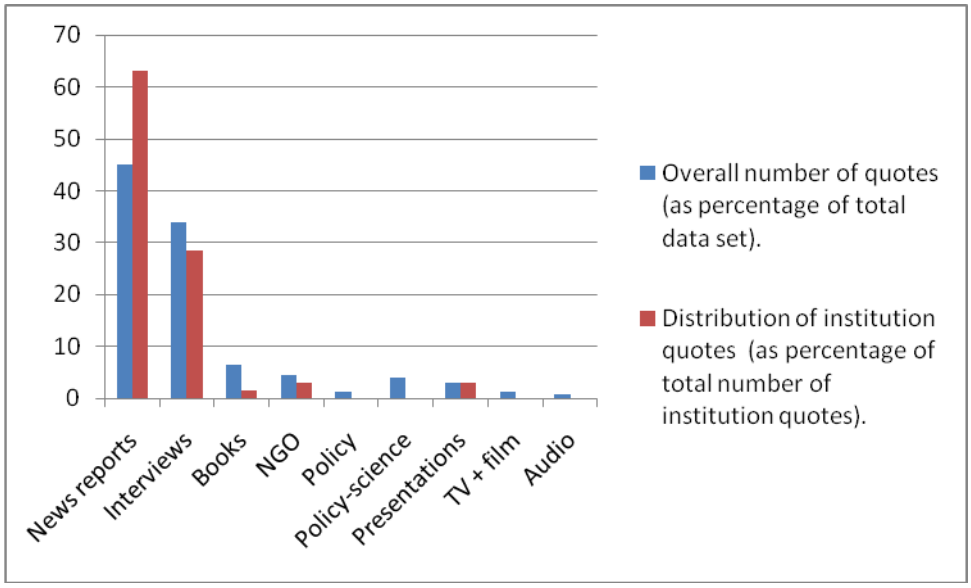
[56] Lowe and Lorenzoni provide a helpful overview of the differing definitions of expert, noting that experts have been defined by distinguishing them from laypeople based on the different cognitive heuristics used by them to arrive at a decision. However, a wide range of subjective values may exist in the framing or definition of what constitutes an "expert", from those that have thought deeply about a particular subject to those that have status of authority in a subject by reason of special training or knowledge (2005: 30).

The codes which are the subject of this first section of my analysis describe quotes which are largely sourced from the media document family[57]. It is the words, actions and communications of powerful actors and institutions which provide the media with a window on the phenomenon of climate change. It is these actions, these words, these events which constitute 'news'. It is here where the media turns in order to understand climate change. This section of the analysis is structured around the code categories listed in *Table 8* (above).

6.2 Institutions

Figure 11 (below) shows that in the news report document family there is a bias towards institutional actors when describing the two degree limit. The blue bar in *Figure 11* represents what percentage of the total number of quotes analysed in this study are sourced from the news report document family (45%).

Figure 11: Distribution of 'institution' quotes across the different document families.



However, of all quotes analysed which describe the two degree limit with reference to an institutional actor, fully 63% (red bar) come from the news report document family. I interpret this pattern to mean that there is a bias in the news report document family towards invoking institutional actors when describing the two degree limit. The only other potentially significant pattern is the bias away from institutional actors in the book document family. Whilst there is no immediate explanation for this pattern, it is possible that news reports, in dealing with

[57] These codes were not grouped together on the basis that they were predominantly to be found in the media document family. It was only as the analysis preceded that this pattern made itself apparent.

constraints of space and reader attention span, use institutional actors as some form of short cut, to quickly and immediately communicate some sense of authority to pronouncements on two degrees, whereas books have greater space in which to explore the arguments, and so are less dependent on this form of shorthand.

The information in *Table 9* (below) displays an orientation to discussing the two degree limit through the perspective of western institutions (IPCC, G8, the EU and the Met Office).[58] Discussion of the two degree limit is more likely to be reported through the words of economic institutions[59] than science institutions. Whether this reflects an orientation to the perspectives of the powerful or an aversion to science is difficult to ascertain.[60]

Table 9: Institution codes and number of quotes for each code.[61]

Type of institution	*Institution name*	*Number of mentions*
United Nations	UN	4
	UNEP	1
Economic	G8	27
	EU	13
	G77	9
	G20	9
	Major Economies Forum	4
	New Economics Foundation	1
Scientific	Met Office/Hadley Centre	22
	World Climate Research Programme	4
	Royal Society	4
	Climate Research Unit, UEA.	1
Science/Policy	IPCC	39
	UNFCCC	4
	Committee on Climate Change	3
	Tyndall Centre	2
	DECC	1
	Grantham Research Institute	1
	International Energy Agency	1
	DEFRA	1
	Carbon Trust	1

[58] Weart (2003) and Fleming (1998) have documented how interest in meteorology accelerated in western nations after WWII. This interest was motivated by security and military concerns, and it is the bodies which were set up to develop meteorological research (including the Met Office) which were the first to identify climate change as a threat to the security interests of the west. The UN and EU were also set-up as part of the process of defining a new world order which would protect the security interests of the west.

[59] I categorise institutions such as the EU and G8/G20 and G77 as economic institutions because membership of these groups is defined by the size of the member states economies, and they are all political institutions in which attempting economic governance is a major function.

[60] Smith has argued for an increasing reticence on the part of climate scientists to act as sources for journalists, worrying their career will suffer if their words are misinterpreted or over-simplified (2005: 1474). Additionally, journalists do not have the expertise to interpret the 'raw' science accurately and feel on safer ground talking to policy makers and environmentalists about the issues (ibid).

[61] See Appendix 2 for details of the work on climate change carried out by each of these institutions.

6.2.1 IPCC

There are four distinct ways in which the IPCC is referenced[62]:

i. The IPCC is seen as an authoritative source of information about climate change impacts. Discussing the IPCC 4th Assessment report, the normally sceptical Daily Express quoted without challenge the words of the chair of the IPCC, Rajendra Pachauri:

> I hope this report will shock people and governments into taking more serious action as you really can't get a more authentic and a more credible piece of scientific work.
>
> Sunday Express, January 28th 2007

ii. The authoritative status of the IPCC allows its reports to be used to prove the claims made by other agents. One senior member of the German Advisory Council on Global Change sought to justify their recommendation of a two degree target by reference to the findings of the IPCC:

> But when you see it across the board the different impacts that you can get and the different uncertainties there, they are all on the table by IPCC and others and you see that when you visualise it you see, you get the problem somewhere between 1 and 2.5 degrees.
>
> Policy/science actor 6

iii. The IPCC has something of an adjudicating role in the climate sensitivity debate. It is a commonplace for both the press and NGOs to refer to the IPCC as the official body for telling politicians what cuts in emissions are required to keep below two degrees of warming. Invoking the IPCC in support of claims about the emissions cuts needed to avoid two degrees of warming can give the erroneous impression that the IPCC has identified two degrees as a dangerous limit.[63]

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[62] See Appendix 5 for a discussion of the roles of the organizations referenced in this study.

[63] Not all references to the IPCC identified in my sample make the claim that the IPCC has identified two degrees as a dangerous limit. Sometimes the IPCC is simply used as a source for descriptions of impacts at particular levels of warming. The point is, whilst some accounts do infer the IPCC as the source of the two degree limit none (outside interview data) explicitly make the point that the IPCC does not define a dangerous limit.

An example of this can be found in the Public Interest Research Centre's 'Climate Safety' report:

> The IPCC's 2007 Fourth Assessment Report states that, in order to limit global temperature rise to 2°C, global emissions must peak before 2015 and fall by 85% by 2050.
>
> Public Interest Research Centre, 2008: 14

One author who invoked the IPCC in making an argument for a two degree limit, when interviewed about his use of the IPCC reports to support that target, sought to step back from the certainty expressed in his article. The original text read:

> These will only be relatively early 'discomfort and damage' impacts, which will occur, say the Intergovernmental Panel on Climate Change (IPCC), if temperature rises do not exceed 2°C. If temperature rises go beyond this, however, then we will move into the 'disaster' zone.[64]

When asked where in the IPCC reports he had identified this description of the two degree dangerous limit, the respondent replied:

> What I was trying to do there was position 2 degrees centigrade as a recognised number and then try and do a couple of things with that and say but actually, I don't believe it. The IPCC impacts scenarios basically um I haven't read them directly its Michael Grubb's summary and what he's saying is what we have been having is really very, very, very early impacts and discomfort and damage.
>
> Consultant 1

This example is an illustration of the 'social amplification of risk' described by Kasperson et.al (1988). We can understand the IPCC reports as (one of many) 'signals about risk' (ibid: 177) which are amplified through a variety of 'social amplification stations' (ibid), in this case a book. Because the IPCC reports are complex and characterised by uncertainty, the amplification can generate distortions, can be an amplification of a particular interpretation.

[64] In order to preserve the anonymity of the respondent I don't identify the source of this text.

These interpretations are based on not only incomplete knowledge, but values, culture and ideology.

This conflation of the two degree limit with IPCC reports was common in my data:

> Even before the advanced model predictions in the IPCC report were available, researchers had been trying to put a figure on how much warming humans can bear. Perhaps surprisingly, and through quite different reasoning, many of them have hit on exactly the same figure of 2 degrees centigrade.
>
> King and Walker, 2008: 93

> Indeed, measured against what the official Intergovernmental Panel on Climate Change says will be needed to keep beneath the two degree level, the developing countries appear to have done better than the rich ones.
>
> *The Daily Telegraph*, December 12th 2009

> We understand that there is an emerging consensus behind an objective of limiting global average temperature rise to less than 2 degrees Celsius compared to pre-industrial levels and that this will require global emissions to peak and begin to decline rapidly within the next decade. Even this scenario will require a reduction of 50-85% by 2050, according to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).
>
> The Copenhagen Communiqué on Climate Change, 2009

> A rise of two degrees centigrade in global temperatures - the point considered to be the threshold for catastrophic climate change which will expose millions to drought, hunger and flooding - is now "very unlikely" to be avoided, the world's leading climate scientists said yesterday. The latest study from the United Nation's Intergovernmental Panel on Climate Change (IPCC) put the inevitability of drastic global warming in the starkest terms yet.
>
> *The Independent*, September 19th 2007

iv. Following on from this last point, the IPCC is criticised for failing to communicate uncertainty about the existence of any particular threshold, or for over reliance on computer

models rather than paleoclimatic evidence in determining what dangers will arise when.[65] These criticisms were not present in the 'broadcast' data, but came from presentations and interviews:

> I'm going to start with some bad news and the bad news is this-2 degrees is no longer the target and the news is contained in a recent paper written by James Hansen of NASA. What Hansen shows is that the profoundly pessimistic assumptions in the latest IPCC report working group 3 are insufficiently pessimistic and the reason for this is as follows. The IPCC assumes that the melting of the ice sheets at the poles will take place in a gradual and linear fashion and Hansen's own work with the palaeontological record shows that it is an entirely implausible scenario.
>
> George Monbiot, Climate Camp presentation, June 2007

> There is now an approach to be aware of, namely the rate of change during the paleoclimatic period. That has taught us that the climate sensitivity is not likely in the range of 2.5 or 3. The only reason the IPCC was driving down this best guess is because it was fixed on models which were built on the experience of the last 40 or 50 years and this paleoclimatic evidence wasn't accounted for. This is a direct consequence of Bolin's dominance of the IPCC for 20 years and since his departure there has been a roll back from the models.
>
> Climate scientist 4

> Scientifically, when you look at the literature on damages in my chapter 19 of IPCC we have a table on there, Table 19.1, where we list the damages horizontally in rows and across the top it goes 1,2 3, 4, 5 degrees of warming. A lot of people including Martin Parry did not like that. He wanted us to be very specific on the thresholds at which these things are triggered and I said "we can't do that". The reason we have words stretching out over a fair amount of space is because some literature suggesting the thresholds are irreversible or unfixable damage are very low, other literature in the middle and some literature at the high end, so all that we can say is that the more you increase

[65] I do not here include criticisms of the IPCC that arose towards the end of 2009 regarding exaggeration of projected impacts. These appear to be industry funded attacks on climate science, and seem designed to undermine attempts to implement emission cuts. These criticisms are not direct attacks on the 'two degrees is a dangerous limit' value statement.

> the pressure on the systems the more the number of the systems which will be at risk and the more intense those risks will be and that is exactly absolutely scientifically defensible based upon the literature. And I've always been a believer in policy and measures over targets and timetables. This is because when you actually look at the climate system in detail and impacts there's a lot of scary things out there. The IPCC did not lie to you but the honest chapters spell out that very rarely do we know the actual thresholds.
>
> Climate scientist 2

6.2.2 Scientific institutions

My interviews with scientists and researchers in the field of climate science and policy saw scientific institutions discussed as part of an historic and sociological account which reveals that the understanding of climate change emerging from these sites is grounded in specific personal, social and political circumstances:

> I guess the way I understand it, it is worth going back to 1979 really because that's when the World Climate Research Programme, what is it, the World Meteorological Office in Geneva, you know that was the sort of forum where meteorological scientists mainly connected, as this was where the EU meteorological office was based originally, the Ministry of Defence. These were the kind of people who were most interested in meteorology, the interest was about war basically, so a lot of these meteorological scientists were connected institutionally with the military, it still is, if not formally. Then the Hadley centre got established in the early 1990s and got set up as a separate place but not quite separate if you know what I mean. So the director of the Hadley centre was also director of the Met Office for a long time.
>
> Science/policy academic 2

> We had 10 years to fix it when I and about 10 colleagues told the US senate over at the world climate conference in '79, I mean I remember having a knock down scream out with the head of the British Met Office who thought it was irresponsible for scientists to talk about policy till we knew everything.
>
> Climate scientist 2

On the other hand newspaper descriptions of the work of climate science institutions such as the Met Office tended to focus on the published reports of these institutions which do not reveal the sociological factors underpinning the process of generating these reports.[66] As a consequence, news reports construct the work of these institutions as objective and generally unproblematic:

> The world's best efforts at combating climate change are likely to offer no more than a 50-50 chance of keeping temperature rises below the threshold of disaster, according to research from the UK Met Office.
>
> *The Independent*, March 9th 2009

> "The two-degree target is impossible, and a three-degree target is implausible," said Paul Domjan, energy fellow at the London-based European think-tank and an author of the report. Domjan said the modelling, done by the world-renowned Hadley Centre at the Met Office but using emissions calculated by the Stockholm Network, highlighted three problems.
>
> *The Observer*, June 8th 2008

> Commenting last month on a climate impact report by the Met Office, David Miliband warned that failing to keep global temperatures to within 2 degrees of the present, would heighten the risk of international conflicts over water and land resources.
>
> *The Times*, December 1st 2009

Opinion pieces from firstly George Monbiot and secondly Caroline Lucas, are more combative about the work of these institutions, but again not as regards the two degree limit:

> The Tyndall Centre says that to prevent the earth from warming by more than two degrees above preindustrial levels, carbon dioxide concentrations in the atmosphere must be stabilised at 450 parts per million or less (they currently stand at 380). But this, as its sources show, is plainly insufficient.
>
> Monbiot, *The Guardian*, September 21st 2006

[66] See 'Laboratory Life' (Latour and Woolgar, 1979) for a full examination of these factors.

> According to scientists at the Tyndall Centre for Climate Change Research, rather than constraining warming to less than two degrees which is essential to our chances of being able to stabilise the climate, the Bill's targets are more likely to contribute to a world that's four or five degrees warmer than in pre-industrial times.
>
> Lucas, *The Independent*, August 23rd 2007

6.2.3 Policy/science institutions[67]

The most notable theme here is the need to discuss the work of these institutions through named individuals, and a tendency to try and reinforce the authority of these institutions:

> The report, written by eight leading German professors, says that "dangerous climatic changes" will become "highly probable" if the world's average temperature is allowed to increase to more than 2 degrees centigrade above what it was before the start of the Industrial Revolution.
>
> *The Independent on Sunday*, December 7th 2003

> The United Nations Environment Programme and Britain's Grantham Research Institute, chaired by Lord Stern, author of the influential Stern report, have jointly published a study concluding that the best offers on both sides amount to up to 80 per cent of the minimum needed.
>
> *The Daily Telegraph*, December 12th 2009

> Is there really any chance of countries meeting the target of keeping the global temperature rise to 2C? Publicly, the government and NGOs say yes, but the facade is wearing thin. Even Lord (Adair) Turner, new chairman of the government watchdog, Committee on Climate Change, is not too hopeful. At a meeting last week, he said his committee's recent report on emissions

[67] The distinction between science institutions and or/actors and policy/science institutions is not always clear, especially in a highly politicised area such as climate science. Generally, where these institutions describe themselves as including actors other than climate scientists (i.e. social scientists, economists, politicians) then they are placed in the policy/science category.

> reductions was based on the "scientific consensus", then added: "I don't think we can stop 2 degrees these days".
>
> *The Guardian*, December 17th 2008

6.2.4 Economic institutions

The focus here is on the institutions structured around economic criteria. I do not simply mean economic institutions such as the International Monetary Fund.[68] Rather, I include forums in which nation states work to develop economic regimes. The quotes identified in my sample come largely from the UK press, and so not surprisingly there is a bias towards those institutions whose decisions will most likely impact on the UK, namely the G8 and the European Union and the Major Economies Forum.

The G8 agreed on a two degree dangerous limit for the first time at their July 2009 summit in L'Aquila, Italy. The same focus and language used to describe events at Copenhagen was apparent in reporting of this summit:

> World leaders last night pledged to stop the planet's temperature rising by more than two degrees. Gordon Brown and US President Barack Obama led the G8 in the historic vow.
>
> *The Sun*, July 9th 2009

> G8 leaders meeting in L'Aquila, Italy, agreed for the first time to work to prevent global temperatures rising by more than two degrees Celsius (3.6 Fahrenheit). Gordon Brown hailed the G8 statement on climate change as "historic'' and a precursor to global talks in Copenhagen in December.
>
> *The Daily Telegraph*, July 10th 2009

> The wealthy countries have come together to recognise the desirability of holding global warming to two degrees Celsius above the pre-industrial level - this is the first time that this has been done, and was never possible, for example, while George W Bush was US President. Barack Obama has made the

[68] In fact, if reference to such institutions had been identified in my sample, then I would have analysed them alongside the other institutions. The absence of banking institutions such as the IMF and World Bank from my data may be because environmental regulation is not the normal sphere of activity for these institutions.

> difference, and the mood music is changing, which is a hopeful sign that a serious agreement may eventually be possible.
>
> *The Independent*, July 10th 2009

> So if we are committed to an increase of 1.2C and more, what is the maximum before the world is condemned to become the Prince's "living hell''? The scientists' best estimate is 2C - and over the past two days both the G8 leaders and the climate summit recognised it should not be exceeded.
>
> *The Daily Telegraph*, July 10th 2009

The disagreements of most concern for Western trading blocs were less about the two degree target, but more about what cuts in emissions were needed to avoid more than two degrees of warming:

> Critics point out that the G8's European members have effectively abandoned their demand that the summit agree to limit any rise in world temperatures to two degrees Centigrade. This would have required a 50 per cent cut in carbon emissions by 2050. Yesterday's deal pledges only to "consider seriously'' this target. It does not make any specific commitments. Daniel Mittler, from Greenpeace, said: "The deal is clearly not enough to prevent dangerous climate change''.
>
> *The Daily Telegraph*, July 9th 2009

The divisions on the defining of a dangerous limit were between the North and South, or more precisely between their dominant trading blocs:

> The Group of Eight industrialised economies, including America, yesterday agreed for the first time that they must limit worldwide temperature rises to no more than 2C, but failed to reach agreement with developing nations on how that should be achieved - a disappointment to those expecting Barack Obama to break a decade long deadlock.
>
> *The Guardian*, July 9th 2009

> Lumumba Stanislaus Di-Aping, chief negotiator for the Group of 77, which represents developing countries, announced that the two degree target "exposes over 100 countries to suffering and devastation'', leading to the disappearance of low-lying island nations and "certain death'' for Africa. And he added that the $10 billion a year fund would not be enough "to buy the poor nations the coffins."
>
> *The Daily Telegraph*, December 12th 2009

A senior member of the World Wildlife Fund climate programme argued that there was not, unlike the G8, any consensus within the G77 on a dangerous limit:

> We don't agree with this global goal of limiting warming. You had the very vulnerable countries in AOSIS with their slogan 1.5 to stay alive who are within the G77 so it became very hard politically within the G77 to not at least want 2 degrees and then again within the G77 the argument then became between those who wanted 2 degrees, those who wanted 1.5 degrees and those who wanted 1 degrees, you know as a threshold to limit to warming to.
>
> Campaigner 11

The Major Economies Forum (MEF), in agreeing a two degree limit is, perhaps unsurprisingly, closely aligned with the attitudes of the G8:

> The eight rich countries and the Major Economies Forum (MEF), a group of 17 other economies including China and India, agreed that average global temperatures should not be allowed to rise more than two degrees Celsius. But there were few firm plans about how to achieve that goal and leaders remain divided even about what the baseline for the rise should be.
>
> *The Daily Telegraph*, July 10th 2009

Exceptionally The Guardian, as the most left - leaning of the newspapers analysed, gave space to analysis from less authoritative economic institutions, economic or otherwise, as in this report:

> Economic growth is not compatible with climate change targets for rich countries, according to a new report out today. The New Economics Foundation warns that global economic expansion is not possible if the world is to restrict the temperature rise to 2 degrees - the EU's agreed political objective.
>
> *The Guardian*, January 25th 2010

Analysis of the institutions invoked in discussion of the two degree limit shows a privileging of Western scientific, economic and policy/science institutions (such as the IPCC). That there should be a focus on Western institutions is not surprising, given my reliance on Western data sources. That science and policy/science institutions are so prominent in my sample should perhaps again not be surprising, given the nature of the climate change phenomenon. However, one can also interpret these patterns in light of Bronstein's theories of the institutional capture of the symbols of risk and danger as an important stage in the management of the responses to the problem. The dominance of science institutions, even where those institutions are serving a policy function, also highlights the extent to which climate change continues to be treated as an instrumental problem which can be managed through science. The presence of powerful economic institutions in the two degree debate is perhaps also indicative of the interests that are challenged by the idea of climate change, and the role the idea of a dangerous limit has in protecting those interests.

6.3 Events

Inevitably, given the event driven nature of news reporting, discussion of the two degree limit through the prism of events came mostly come from the press (see *Figure 12,* below) and the event most frequently cited is the UNFCC Copenhagen Summit of December 2009.[69]

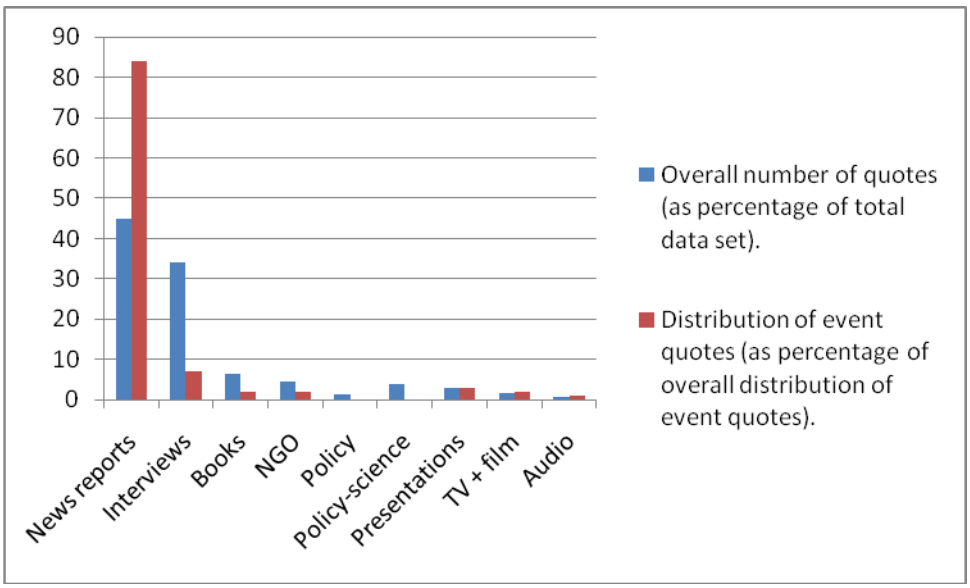
My sample contained seventy eight stories on the Copenhagen Conference, some 75% of the total "Events" quotes, compared to only seven mentions for the Kyoto Protocol and three mentions of the 2005 Montreal UN Climate Conference. There are two probable explanations for this difference. The first is that the search term applied in the Lexis-Nexis database was

[69] Events play an important role in reporting on climate change. 'Scientific information, as such, is relatively unattractive for media coverage. But its newsworthiness increases if identifiable events can be linked to a scientific issue or if a threat to human life is involved'. (Weingart, Engels and Pesengrau, 2000: 263).

"two degrees". Agreeing a global dangerous limit to climate change was not an over-arching theme of the previous conferences as it was at Copenhagen, and so it is perhaps inevitable that the stories retrieved from Lexis-Nexis under the two degree search term would be weighted towards Copenhagen rather than other preceding conferences.

This is not the full explanation however. Other statements on two degrees from institutions such as the EU or from the Exeter conference on defining dangerous limits, held in 2005, have not received as much publicity as Copenhagen. The need for journalists to tell a story through personalities maybe one reason why there was a focus on Copenhagen - this was a coming together of world leaders in a setting promising conflict and intrigue (see discussion of the "Political Actors" data below).

Figure 12: Distribution of 'Events' quotes across the document families.



Complex scientific conferences lacking the attendance of recognisable personalities will not hold such appeal for journalists. Another reason maybe that climate change is now firmly embedded in the news agenda, is a dominant theme and story in politics and world affairs. For that reason it may have been easier to give prominence to covering the conference which may not have been so easy to justify in 2005.

I begin with analysis of the events other than those associated with Copenhagen.

6.3.1 2003 European Heat wave

The European heat wave, described as the biggest natural disaster in Europe for 50 years (UNEP, 2004) received little discussion in my data set, yielding only seven quotes, three from newspapers, four from books[70], and one from TV and film.[71] This does not necessarily show a neglect of the topic, so much as little association of the event with the two degree limit. The heat wave was simply not frequently identified as having any lessons to teach us about the idea of a two degree dangerous limit. Where it was argued that the heat wave was a product of climate change, that the impacts were sufficiently deleterious to be considered dangerous, and that such heat waves would be much more frequent if there was a two degree rise in average temperatures, there was no accompanying call for a revisiting of the two degree target[72]:

> The planet may suffer a three-degree rise in temperature. This would be one degree higher than the "danger level" warned of by the European Union for creating the unbearable heat wave summer witnessed across the Continent in 2003.
>
> *Sunday Express*, January 28th 2007

> Two degrees is bad for nature, but Lynas reckons that most of us will get by, although we will face regular repeats of the heat wave that struck Europe in 2003.
>
> *Sunday Times*, April 8th 2007

> The 2003 European heat wave is likely to become an annual event under two degrees of warming.
>
> Lynas, 2007: 66[73]

[70] This represents 50% of all the quotes in my sample discussing dangerous climate change in relation to the heat wave. Given the small size of the sample it is not possible to attribute any significance to this pattern, and no robust explanation readily presents itself.

[71] The European heat wave of 2003 was the event that sensitized me to potential shortcomings in defining two degrees as a dangerous limit to climate change. The heat wave occurred against a backdrop of approximately 0.7 degrees of warming over the 20th century. Thirty thousand people are estimated to have died during the heat wave. Under these circumstances it seemed that two degrees of warming (almost three times the warming which had occurred by the time of the heat wave) was too high to be considered a threshold between safety and danger.

[72] The report from the Sunday Express demonstrates confusion over the relationship between warming and impacts, assuming that the heat wave was the result of two degrees of warming. Ambiguity and confusion over what impacts will occur when is discussed further in the next section of this analysis. The quote from Bob Watson is a reference to the fact that the heat wave was the product of European summer temperatures being two degrees above the norm for that time of year.

[73] This passage is from the book in which Mark Lynas argues for a two degree limit. Likewise King and Walker, although interpreting the heat wave to mean it is now too late to stop dangerous climate change, still go on to argue for a two degree limit.

> Many previous attempts to decide how far we should allow our climate to go began with the idea that we should stop climate change before it becomes "dangerous". However, it's too late for that. As we explained in Chapter 3, climate change set the stage for the 2003 European heat wave that killed more than 35000 people.
>
> King and Walker, 2008: 89

> The 35,000 Europeans who died in the heat wave in 2003 were victims of an event that almost certainly would not have happened without the insidious increase in background temperatures that turned a warm summer into a killer.
>
> Pearce, 2007a: 351-352

> So when you effectively say we could be lucky and only see a 2 or 3 degree warming that's equivalent to the 2003 heat wave, where thousands of people across Europe died.
>
> Watson, Darwin lecture, 14th March 2010

6.3.2 Conferences

My sample includes few references to conferences other than the 2005 Exeter 'Avoiding Dangerous Climate Change' conference (Blair et al., 2005), and the 2009 UNFCCC Copenhagen conference. Despite the perceived importance of the Kyoto Treaty and the extensive discussion it has received in a range of publications, because the Kyoto targets are not explicitly tied to a two degree goal then it does not bear directly on my research and references to it do not appear very frequently in my sample.[74] There is some discussion of the Kyoto Protocol in news stories that I have sampled because those stories include discussion of the two degree target.

[74] One important impact the Kyoto Protocol seems to have had on the discussion of dangerous limits is in the setting of baselines. By this I mean that up until 2007 the dangerous limit was claimed to be two degrees of warming above the pre-industrial average. The Kyoto Protocol brought into force in 2005 used 1990 as a baseline for emission cuts, i.e. cuts would be measured against what was being emitted in 1990. This was a bit of a fudge as it was seen as being too generous to the Russians and too harsh on the US, because the economic crash in Russia following the end of communism meant Russia's emissions dropped rapidly after 1990. However the US had seen its emissions rocket between 1990-2005, making any cuts more difficult to achieve (King and Walker, 2008: 184). From 2007 there seems to have been a quiet shift to the 1990 temperatures as a baseline for dangerous warming, rather than the pre-industrial average.

However the discussion of the Kyoto Protocol in these reports is very tangential to the two degree limit and so is not examined in this qualitative analysis.[75]

The 'Avoiding Dangerous Climate Change' conference receives little mention in the data, despite some influential commentators citing the conference as the source of the two degree dangerous limit.[76] This neglect is likely the consequence of the complex scientific nature of the conference, which produced no definitive statement on the two degree limit.[77]

Where the Exeter conference is mentioned, certainty is imposed, and the impression given that two degrees is a dangerous limit:

> The Government's conference on Avoiding Dangerous Climate Change, held at the UK Met Office in Exeter a year ago, highlighted a clear threshold in the accumulation of greenhouse gases such as carbon dioxide (CO_2) in the atmosphere, which should not be surpassed if the 2 degree point was to be avoided with "relatively high certainty."'
>
> *The Independent*, February 11th 2006[78]

The Copenhagen summit was billed as a 'last chance saloon' for humanity (King and Walker, 2008: 196), the 'most important meeting in human history' (*The Guardian*, September 2nd 2009). Thus human salvation was equated with reaching a global agreement on the two degrees dangerous limit:

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[75] See Newell (2000) for an analysis of the issues addressed in this thesis as they apply to the formulation of the Kyoto Treaty.

[76] For example, Roger Harrabin, the BBC's environment correspondent (personal communication, 29th March 2010). King and Walker discuss the Exeter Conference as part of their timeline of the dangerous limit concept but do not claim that agreement was reached at the conference on how much warming is dangerous (2008: 94). They do however cite another report from 2005 which was co-authored by scientists and politicians (The Climate Change Taskforce) which did argue for a two degree limit.

[77] Journalists seek certainty: 'News does not like nuance. Try writing an uncertainty headline' (Roger Harrabin, personal communication, 29th March 2010). See also discussion on uncertainty in this analysis.

[78] Compare this with what one respondent who attended the conference recalled when I asked if the Exeter Conference was where the two degree limit originated:

> That was not my understanding. I think this whole conference was set up and Tony Blair wanted this conference to come up, the language was I think ...Tony Blair wanted to figure out a level that was self evidently safe, or maybe he used the danger metaphor, I can't remember. But that was the whole purpose of having the whole conference. But from what I recollect, in response to Bush's statement, "what level of greenhouse gases in the atmosphere is self – evidently too much" I don't think the conference endorsed any specific level.
>
> Science/policy academic 4.

> The experts tell us that the only way to stay below that 2C limit is for global emissions to peak in 2015 - and then start falling. In other words, we have set ourselves up at a nice corner table in the last chance saloon. Copenhagen is that last chance.
>
> *The Guardian*, September 16th 2009

> Two degrees is the talisman. Limiting climate change to 2 degrees Centigrade above the pre-industrial level has been the target for the European Union for 13 years, for the G8 group of nations since July, and next week is likely to be officially enshrined in the Copenhagen agreement as the great symbolic climate target for the whole world. You'll see it in the headlines (if the conference doesn't fall apart in the meantime). Two degrees, everybody!'
>
> *The Independent*, December 10th 2009

In the lead up to the summit such concern as was expressed over the targets related to the emission cuts, and what reduction was needed in order to avoid more than two degrees of warming:

> A while ago I had a dispiriting conversation with another eminent European scientist. He is a natural optimist but sounded unusually low. He had recently been asked to brief a leading European political figure on the latest scientific understanding of climate change. The leader listened then described the best deal he believed possible at Copenhagen: a 50% global cut in emissions against 2000 levels - by 2050. The scientist explained that such a deal would give us only a 50% chance of avoiding a temperature rise above the critical two-degree level that experts believe could trigger runaway warming.
>
> *The Guardian*, September 1st 2009

> The emissions cuts offered so far at the Copenhagen climate change summit would still lead to global temperatures rising by an average of 3C, according to a confidential UN analysis obtained by the Guardian. With the talks entering the final 24 hours on a knife-edge, the emergence of the document seriously undermines the statements by governments that they are aiming to limit emissions to a level ensuring no more than a 2C temperature rise over the next

> century, and indicates that the last day of negotiations will be extremely challenging.
>
> *The Guardian*, December 18th 2009

> Take the medium-term target for cutting CO_2 emissions. Should industrialised countries like Britain cut them by at least [25-40] [in the order of 30] [40] [45] per cent by 1990 levels by 2020? Or take the long-term target for all countries to scale back CO_2. Should parties collectively reduce global emissions by at least [50] [85] [95] per cent from 1990 levels by 2020? Or if it's just the rich countries by themselves and their long-term targets, should they reduce emissions by [75-85] [at least 80-95] [more than 95] per cent by the same date? Over it all we have the ultimate ambition - the proposal that the increase in global average temperatures above pre-industrial levels ought not to exceed [2 degrees C] [1.5 degrees C]. Never in history have such momentous choices for all our futures been encapsulated in a few rows of adjacent punctuation marks, which emerged yesterday when the draft text for a potential Copenhagen agreement was published.
>
> *The Independent*, December 12th 2009

Nonetheless, despite these concerns, it was common to consider reaching agreement on a two degree limit as something of a triumph:

> In Copenhagen we actually may get a sort of under the UN convention a full acknowledgement and maybe even an adoption of the two degree target. It's probably the best we can get in Copenhagen because no-one should dream of the possibility that there will be numbers reduction measures for each country in the world which will be sealed in Copenhagen this year, but if we get first of all a long term target then we get the right framework then we are in much better shape than we are now.
>
> Schellenhuber, conference presentation, September 15th 2009

> We got agreement on 2 degrees which really we just got for the first time in Copenhagen the first time when the vast majority of the world's leaders came together and said this is what we should be aspiring to do that is our goal. It's

> now clear that this is the goal and now we can see whether countries measure up to that goal.
>
> Campaigner 11

Claims from more vulnerable countries that the two degree limit was too high did provide the opportunity to discuss other perspectives on the two degree limit. The Mail on Sunday quoted one delegate who gave an analysis of the two degree limit which closely mirrors some of the concerns expressed by respondents interviewed for this thesis. However these comments were framed as controversial and dismissed as an overreaction. As this is the only instance in the news report document family of the two degree limit being interpreted as a displacement of the risk onto the poor it is worth quoting at length:

> A diplomat has sparked outrage by comparing the climate-change deal reached in Copenhagen to the Holocaust. Lumumba Di-aping, chairman of the G77 group, which represents 130 of the world's poorest nations, said the non-binding agreement would mean the deaths of millions because of the effects of global warming such as floods and droughts. Mr Di-aping, a Sudanese diplomat, described the deal as 'devoid of any sense of responsibility or morality'. 'It is a solution based on the same values that funnelled six million people in Europe into furnaces,' he said.
>
> The Copenhagen Summit, estimated to have cost £130million, came to a close yesterday without a binding global agreement to limit carbon emissions. Instead, US President Barack Obama brokered the Copenhagen Accord, crucially with the agreement of China, which aims to keep average temperature rises to below 2C (36F) and pledges money to help poor countries combat global warming. But Mr Di-aping insisted the Accord “asks Africa to sign a suicide pact, an incineration pact, in order to maintain the economic dominance of a few countries”.
>
> Energy and Climate Change Secretary Ed Miliband hit out at Mr Di-aping, accusing him of trying to wreck the talks and offering 'disgusting comparisons to the Holocaust which should offend people from across this conference from whatever background they come'. Sweden's chief negotiator Anders Turesson said: 'The reference to the Holocaust is, in this context, absolutely despicable.
>
> *Mail on Sunday*, December 20th 2009

Elsewhere reporting on the concerns of poorer nations was more muted:

> National leaders and sleep-deprived negotiators thrashed out a text late last night that could determine the balance of power in the world and possibly the future of our species. The list below gives a breakdown of the key points:
>
> Temperature
>
> "The increase in global temperature should be below two degrees."
> This will disappoint the 100-plus nations who wanted a lower maximum of 1.5C, including many small island states who fear that even at this level their homes may be submerged.
>
> *The Guardian*, December 19th 2009

> This conference was supposed to be coming up with a level of greenhouse gas emissions that will stabilise temperatures at not more than 2 Celsius. The poor countries upped the bar by saying actually they wanted 1.5 Celsius or 1 Celsius... and many, many more in a long, long list of ambitions.
>
> *BBC Radio 4 newspod*, December 18th 2009

Overall the reports construct the summit as a success in achieving widespread recognition amongst industrialised nations that two degrees is a dangerous limit, combined with anxiety that this is not supported with legally binding emission cuts. Concern from developing nations that two degrees does not separate safety from danger are not seen as cause to re-examine the validity of the two degree target.[79]

This part of the analysis has shown the Copenhagen Summit to be the primary event that features in discussion of the two degree limit in news reports. Such a result might be expected, given the two degree search term used, and the focus at the summit on agreeing a limit to warming. Yet the approach to the negotiations was to focus on the personalities of elite actors, and to relay the process as a drama. These findings fit with those media theories which argue

[79] In April 2010, as a riposte to the Copenhagen summit the President of Bolivia, Evo Morales, convened the 'World People's Conference on Climate Change and the Rights of Mother Earth'. Despite concerns raised by the Annex 2 countries at Copenhagen, the People's Agreement that came out of the World People's Conference uses language remarkably similar to that which characterizes climate change discourses in the west**. '**If global warming increases by more than 2 degrees Celsius, a situation that the "Copenhagen Accord" could lead to, there is a 50% probability that the damages caused to our Mother Earth will be completely irreversible. Between 20% and 30% of species would be in danger of disappearing' (People's Agreement, April 2010).

the media compete for the reader's attention by the provision of novel and engaging story lines. The Copenhagen story lines also, I argue, communicate the sense that decisions about dangerous limits are not a subject for democratic debate, but are best made by experts and leaders thinking rationally on the basis of sound scientific evidence.

My data indicates the European heat wave of 2003 was not considered to provide any important insights on the two degree dangerous limit debate in any of the sources I analysed. Whilst one could potentially argue that for the media, such an investigation would have little appeal for its readers, such a lacuna from data sources such as books and film is not so readily explained.

6.4 Political leaders

Of the 87 quotes linked to the "Political leaders" code, 83 came from the newspaper document family.[80] The media reports in my sample ignore structural accounts of the climate target negotiation process in favour of personality driven storylines. These accounts are generally given against the backdrop of international conferences and agreements. The personalities who populate these stories are predominantly national leaders from the Annex 1 countries. References to the roles played by political leaders at the Copenhagen summit predominate in my sample.[81]

The only exception to this rule came from campaigner who focussed on calls from the Annex 2 countries for a lower than two degree limit:

> Actually in the Copenhagen Accord there's a reference to 1.5 degrees and more recently in the Bolivian meetings that they're having Eva Morales has said the goal should be 1 degree as well, so it's become, it's a way you know that political leaders have been framing this issue for the last year.
>
> Campaigner 11

Newspaper accounts invest Annex 1 political actors with a profound sense of agency in climate change negotiations:

[80] These results accord with the findings of Carvalho and Burgess, who concluded in their analysis of media reporting of dangerous climate change that 'coverage of climate change has been strongly linked to the political agenda on this issue, and particularly to public pronouncements and discursive strategies of prime ministers and other top governmental figures. (2005: 1467). A study of media coverage of Copenhagen found less than 10% of the news stories dealt with the science of climate change (Reuters, 15th November 2010).

[81] This is perhaps inevitable given that 'the attendance of 119 world leaders made the Copenhagen talks the largest gathering of heads of state and government in the history of the United Nations' (Mail on Sunday, December 20th 2009).

> Is Gordon Brown setting out to save the world - again? It seems so.
>
> *The Daily Telegraph*, October 20th 2009

> Start reading here, Barack: Only one person can now rescue these climate talks. This is the speech to turn shambles to triumph.
>
> *The Guardian*, December 17th 2009

> If Obama can't defeat the Republican head bangers, our planet is doomed.
>
> *The Guardian*, September 16th 2009

> You have become President at a crucial moment in the planet's history. We are close to the climatic Point of No Return: a two-degree rise in temperatures, which will trigger an unravelling of all natural processes. The last two Presidents killed Kyoto. You can save its successor, which has to be negotiated before 2012.
>
> *The Independent*, November 20th 2008

> We'll never get a better chance to save the planet; Copenhagen...climate battle is on plea as Obama acts.
>
> *The Sun*, December 8th 2009

> Obama must be at summit and leading from the front'; president's presence is crucial.
>
> *The Times*, October 27th 2009

> Can Obama save us from hell?
>
> *The Daily Telegraph*, July 10th 2009

The focus on heroic individuals fighting against the odds to save our planet by agreeing to avoid more than two degrees of warming is extended into reports of 'an exhausted Ed Miliband' (*The Observer*, December 20th 2009) or 'an exhausted Gordon Brown (*The Sunday Telegraph*, December 20th 2009) returning from the conference.[82]

[82] These war like metaphors have been identified as a key trope in reporting on climate change elsewhere. 'The antagonistic relationship between the stakeholders in the controversy and their polarization are strengthened by

6.5 Environmental Campaigners

Of the 35 quotes identified in this sample as discussing the two degree limit with reference to, or through, the words of campaigners, 32 came from the newspaper document family. In the majority of the reports, campaigners' opinions are included as a balance to the official position; their opinions and reports are normally not the driver of these stories but instead appear at the end of the article. There were some notable exceptions to this pattern, for example reporting on protests and marches:

> More than 22,000 people descended upon Trafalgar Square in London yesterday to call for urgent action on climate change. The event, organised by the Stop Climate Chaos coalition, took place on the eve of global climate talks in Nairobi, Kenya. Activists urged the Government to negotiate an international deal to keep global warming to below two degrees Celsius and introduce a Climate Change Bill into the Queen's speech.
>
> *The Independent on Sunday*, November 5th 2006

> Sometime after midnight, on Sunday morning, I was standing on the site of the Climate Camp, watching a marquee being constructed and chatting to an amiable chap who had recently joined a hundred others in seizing the field under the cover of darkness and the noses of the police. I asked him why he was there. "The Government says we need to stay under 500ppmv,'' he said, sipping a cup of tea. "Their Chief Scientific Adviser says 450, but realistically...''
> "I'm sorry,'' I replied. "I've absolutely no idea what you're talking about''. [83]
>
> *The Daily Telegraph*, August 17th 2007

The Daily Telegraph, a paper aligned with many small 'c' conservative ideals, carried a report from campaigning groups which presented a greater than two degree rise as a threat to the traditional English landscape:

---

the deployment of metaphors referring to physical struggle, and the use of military vocabulary additionally underscores the dramatic character of the issue at hand' (Oluasson, 2009: 427).

[83] A telling example of how the seemingly simple issue of the relationship between greenhouse gas concentrations and temperature rises is reported as a complex matter best left in the hands of scientists and other experts.

> Many scientists and politicians now accept that climate change is largely man-made and that any increase in the global average temperature above 36F (2C) would have catastrophic consequences for our way of life.
>
> To prevent this happening wealthy countries will have to cut their carbon dioxide emissions, which are widely thought to be the main cause of climate change, by at least 80 per cent by 2050, it is suggested. In the report, called Our changing climate, our changing lives - South East, 11 groups, including the National Trust, National Federation of Women's Institutes, the Woodland Trust and WWF warn that the South East will probably remain one of the hottest and driest parts of England.
>
> *The Daily Telegraph*, February 26th 2008

Campaigner perspectives tend to appear towards the end of a story to provide balance. These alternative viewpoints are supportive of the two degree dangerous limit, but challenge the emission cuts seen as necessary to achieve those targets:

> Martin Kaiser, of Greenpeace, welcomed the announcement, saying it would put pressure on Western leaders to agree a more ambitious deal at the summit. Western diplomats also welcomed it, but said it was not ambitious enough to help meet the goal of sufficient cuts to restrict global warming to two degrees by 2050.
>
> *The Daily Telegraph*, December 4th 2009

> Keith Allott, head of climate change at the WWF-UK, said: "The IPCC report confirms that climate change is real, it is manmade and that if it continues unchecked it will be disastrous for human society and for nature. "To avoid the worst impacts, the increase in temperatures must be kept below two degrees centigrade. This can be done but the window of opportunity is closing quickly. We need to get global emissions on a downward path within a decade."
>
> *Sunday Express*, January 28th 2007

> Green groups such as WWF and Oxfam argued the 2C aspiration was severely weakened by the lack of interim targets on how it should be achieved. Kim Cartensen, the WWF Global Climate Initiative leader, said: "If they don't

> outline a path to reach an announced goal, the two degree statement will just join a long list of broken promises. An ambitious mid-term target for 2020 of developed countries is needed to ensure immediate action."
>
> *The Guardian*, July 9th 2009

> Andy Atkins, the executive director of Friends of the Earth, said: "This toothless declaration that the US is spinning as a success is a sham - this agreement won't stop a two-degree rise in temperature.''
>
> *Sunday Telegraph*, December 20th 2009

> Mr Brown and world leaders believe the agreed global temperature rise limit of two degrees will prevent the catastrophic effects of climate change. But a coalition of environment groups said it still did not go far enough. Climate Action Network International estimate that the "emissions path" will still raise global temperatures about four degrees celsius, inflicting massive damage on the planet.
>
> *Daily Mirror*, December 18th 2009

6.6 Experts

Experts were most often referenced in media reports, again reinforcing the dependence of the media on authoritative voices when discussing climate change with the effect of black-boxing the notion of a two degree limit.

There are 44 quotes under this category. 25 of these cite three named actors; Sir Nicholas Stern (18), Sir David King (5), and Lord Turner (2)[84]. All but two of these quotes were from newspapers. The other 19 quotes refer to anonymous “experts”, 18 of which appeared in media reports.

[84] Sir Nicholas Stern is the eponymous author of a highly publicised report, published in 2006, on ‘the economic challenges of climate change and how they can be met, both in the UK and globally’ (Office of Climate Change website). Such was the coverage that the report received that Nicholas Stern has been described as the ‘rock star’ of the modern climate change movement: ‘when he speaks, the whole world listens’ (*The Guardian*, 30th March 2009). The predominance of the coverage given to his economic analysis of climate change is reflected in the number of quotes from Nicholas Stern identified in my sample as compared to the other named experts. Sir David King was the Chief Scientific Adviser to the UK government from 2007 - 2007. Lord Turner, previously Director-General of the Confederation of British Industry, is the chair of the Committee on Climate Change, ‘an independent body established under the Climate Change Act to advise the UK Government on....reducing greenhouse gas emissions’ (Committee on Climate Change website; see Appendix 5 for details on the work of the Committee on Climate Change).

These voices were generally invoked as authoritative, rational voices which challenge climate sceptic viewpoints, or the belief that concern about climate change was the preserve of green fanaticism. Therefore, within a framework which generally assumes the two degree limit to be a very stringent target, the opinion of these actors were used to argue that however stringent, it is necessary.

6.6.1 Named experts

Some newspaper reports invoke Stern's report to provide economic justification for taking action on climate change, whilst recognising that what is suggested will not prevent more than two degrees of warming. As before, the debate is not whether two degrees is a dangerous limit, but what emission cuts will achieve the desired goal:

> Levels of carbon dioxide in the atmosphere are already at 430 parts per million (ppm), and in his book Lord Stern says the world has "probably missed the chance'' of keeping emissions below 450 ppm. This means temperatures are likely to rise by at least two degrees Celsius by the end of the century.
>
> *The Daily Telegraph*, April 21st 2009

> His climate change report, published yesterday, is long, detailed and impressive. It has the admirable objective of trying to cap global warming at two degrees or a little more. This, it says, means that greenhouse gas pollution in the UK should fall by 80% by 2050 and by 31% by 2020. But there's a problem. There is no longer any likely relationship between an 80% cut and two degrees of warming.
>
> *The Guardian*, December 2nd 2008

> Nicholas Stern's doubling from 1% to 2% of GDP the amount he thinks needs spending on mitigating climate change is welcome, but why hasn't he gone the whole hog and trebled it to the 3% identified in his original report, which may give us an evens chance of keeping within a two degrees temperature increase?
>
> *The Guardian*, June 28th 2008

The *BBC online* news service provided the only instance in my sample of the Stern Review being criticised for economic assumptions rather than climate sensitivity issues:

> The Stern report commissioned by the UK government argued that it would cost less to avert serious climate change than to deal with the consequences, though some economists have challenged parts of the calculation.
>
> *BBC News online*, 3rd September 2007

These disputes are reflected in the discussion of policy pronouncements from the other named experts:

> This echoes the refusal of Sir David King, the government's chief scientist, to call for a target of less than 550 parts per million of CO_2 in the atmosphere, on the grounds that it would be "politically unrealistic". The message seems to be that the science can go to hell - we will tell people what we think they can bear.
>
> *The Guardian*, September 21st 2006

The report below indicates some back tracking on the part of Sir David King on his initial call for a 550ppm level. There is no revisiting of the two degree target though:

> The danger was highlighted by Sir David King, Blair's chief scientific adviser, when he reiterated last week that a key goal of the summit should be greenhouse gas stabilisation in the atmosphere. Quite right. But Sir David added ominously that the British position - for 450-550 parts per million (ppm) - would be an implicit weakening of the EU agreement in March and wave goodbye to averting climate chaos. This range is simply inadequate to stop global warming of more than 2C above pre-industrial levels.
>
> *The Guardian*, June 26th 2007

This fluctuation in desired concentrations of greenhouse gases around a stable dangerous limit is also characteristic of the work of the other named expert who appeared more than once in my sample:

> Already, there are signs that Milliband would like the government to be more ambitious in this area. It has accepted Lord Turner's recommendation that in order to limit global warming to two degrees above pre-industrial levels, CO_2 emissions must drop by 80% by 2050. The previous target was 60%.
>
> *The Guardian*, November 6th 2008

6.6.2 Unnamed experts

There are a number of ways of lending an air of authority to pronouncements on complex and controversial topics such as dangerous climate change. Elsewhere in this analysis I examine how science is used to cloak the idea of a two degree dangerous limit in the mantle of objective knowledge. However, as the following representative quotes show, it is not always necessary to align this expertise with a particular epistemology or discipline[85]:

> Experts believe that the world must keep the rise in temperature to less than two degrees Celsius if catastrophe is to be avoided.
>
> *The Independent*, July 10th 2005

> The experts tell us that the only way to stay below that 2C limit is for global emissions to peak in 2015 - and then start falling.
>
> *The Guardian*, September 16th 2009

> Britain will find it 'impossible' to meet its target as part of the world's battle to ensure temperatures do not rise more than 2C - a key threshold for dangerous climate change, according to a study by a panel of leading experts.
>
> *The Observer*, June 8th 2008

6.7 The public

Public here means the non-expert part of population, namely neither policy actors, scientists, academics, journalists or environmental campaigners. Very few references to public opinion appeared in my sample and, contrary to the pattern for the other codes, only one newspaper report. Where the public were mentioned they were accorded free agency, and the final arbiter of the political decision making process. However, infrequent mention of public opinion in the literature would indicate that public opinion is perhaps not so significant as some

[85] In my sample reference to “experts” is limited to the liberal media. This may be as much to do with the types of reports being discussed, which perhaps are not seen by tabloid editors to be of interest to their readers.

commentators describe it. I have grouped media and the public quotes together because debate about public involvement with defining what counts as dangerous is almost invariably tied up with discussion of the media's role in shaping public consciousness:

> I don't think it's just driven by the nature of the political system. I think that's part of it. If we pushed for a 1 degree limit the political system would reject us. But I think we also operate within a public sphere, with the media and a broader public.
>
> Campaigner 1

> I don't think we have got that engagement, people who are engaged in so far as they understand that there is an issue called climate change. A lot of people still like to argue the climate sceptic debate because the media has been so open to that for so long. If you're bringing it down to a level of real action and real compromise I just don't think the engagement's there yet.
>
> Policy/science academic 1

> Everybody should be involved in discussions about what is dangerous, there is no right answer to that. How do you get people involved in complexity when the media chooses between the end of the world and everything is ok.
>
> Climate scientist 2

> And of course because we've got this incoherence in the scientific community and the lack of a focussed message who is it that colonises the space then between the policymakers and the general public and the scientists well its people like me, hacks, NGOs who of course their job is to be professional communicators and the NGOs whenever they put out their latest campaigns on climate change they say "the science says that" or the "scientists say that" and ultimately the scientists don't say that or don't think they say that but because there is no coherent message from the science community anyone can say anything they like about what the scientists say.[86]
>
> Mark Lynas, 4 degrees conference panel discussion, September 15th 2009

[86] This statement offers a concise summary of one the major questions addressed in this research. However, this doesn't stop Mark Lynas arguing elsewhere for a two degree limit on the basis of a consensus across a broad range of different social institutions and campaigning organisations (though not scientists).

Elsewhere it was the government, not the media, who were seen as the barrier to public engagement with this debate:

> The public doesn't like to be interfered with the way we travel the way we use things in our home what we buy all those kind of things that those kind of sacred personal freedoms that the government, especially in a neoliberal age, doesn't interfere with. So until those kinds of public perceptions change and the public looks to govt and sees climate change politics as good politics I don't think you are going to get change in the willingness of policy makers to move forward.
>
> Policy/science academic 1

> The challenge of our era cannot be left to governments: Stopping climate change needs a generation to take action, as battles for votes and equality once did. Help lead the way.
>
> *The Guardian*, September 2nd 2009

6.8 Discussion

This analysis of institutions, actors and events has revealed some notable quantitative and qualitative patterns.

The majority of the quotes (62% of the total) came from the media document family, indicating a preference in the media for discussing the two degree limit through the words and actions of prominent and authoritative voices, mostly economic in nature. Whilst less than 25% of IPCC quotes come from media documents (8 out of a total of 39), 24 of the 27 mentions of the G8 identified come from the media document family, 12 of the 13 mentions of the EU and 3 of the 4 references to the Major Economies Forum.[87]

The Copenhagen Summit did offer some opportunity for the voices of Annex 2 countries to be heard[88]; the media document family provided 4 of the 5 mentions of the G77 in my data, though in two instances this was to report controversies over remarks made by representatives of the G77 about what impact two degrees of warming would have for developing nations.

[87] These findings support Stocking and Holstein's claim that 'most research in mass communication has found journalism to be profoundly conservative in support of existing power structures and the status quo' (2009 : 139).

[88] But see Hargreaves, Lewis and Speers (2003: 21) for discussion of 'inward looking' reporting of climate change impacts in the UK media.

This focus in the media document family on the discussion of two degrees through economic institutions must be compared with the media treatment of science and science/policy institutions' perspectives on the two degree limit. Regarding the science institutions, the media made no reference to the World Climate Research Programme but was the source of all four mentions of the Royal Society. Two of these were references to scientific papers issued by the Royal Society; one was to lend credence to predictions of impending catastrophe and the other was an aside that did not bear materially on the discussion of two degrees. Whilst one cannot draw very strong inferences from such a small number of quotes, this bias towards the Royal Society may be an attempt to make the scientific source of these accounts more familiar to the UK public, which probably has little knowledge of the World Climate Research Programme. In that sense, the media are anchoring the debate in familiar ideas and institutions, and lending authority to the claims.

The Hadley Centre and Met Office are two parts of one organisation, hence my conflating the two for the purposes of analysis. Fifteen of the twenty two references to this institution came from the media document family. Of those fifteen, ten were quotes from the Met Office. In the five references to Hadley Centre reports, the Hadley Centre is described as the 'Met Office's Hadley Centre'. This is worthy of mention as generally the pattern of media document family quotes suggests a prejudicing of economic institution accounts and an aversion to scientific and social science discussions of the two degree dangerous limit.[89] The Met Office is, to the UK public at least, a familiar organisation by dint of the weather forecast service broadcast several times a day by the BBC via television, radio and website. Thus, where scientific sources are used, they tend to be the most familiar in the climate science field. What these discussions of Met Office pronouncements on the two degree limit don't reveal is the intense negotiation that goes on behind the scenes about discussion of the two degree dangerous limit.[90]

The media document family makes no mention of the UNFCCC, but provides extensive reports from the Copenhagen summit, an event convened by the UNFCCC. So, rather than the Copenhagen summit being identified as one step in a, protracted and still unresolved eighteen year, multi-disciplinary attempt at defining a dangerous limit, it is instead constructed as a

[89] Whilst it is possible to argue this may simply reflect an absence of discussion of the two degree limit in climate science papers I argue, on the basis of data from the following sections of this analysis, that claims that the two degree limit is scientifically derived must mean the existence of a body of scientific literature supporting this argument. That the media relies on interpretations of this scientific literature from economic institutions is noteworthy and in need of explanation. The alternative explanation, that there is little scientific literature on this topic, is again a noteworthy explanation in need of explanation. An additional explanation is proposed by Newell, who argues media coverage purposefully ignores more unconventional and challenging accounts (2000:77). Economic frames, in reflecting the dominant policy norms, will exclude these more troublesome perspectives.

[90] See Section 3 of this analysis for discussion of these negotiations.

predominantly political event at which world leaders have just a few days in which to thrash out an agreement to save the world from dangerous climate change.

That the Copenhagen summit did not feature so prominently in other document families is probably attributable to timing, with many of the interviews and publications examined being produced prior to Copenhagen. Where these other documents do mention the upcoming Copenhagen summit, they share the same "last chance" language found in the news report document family and also construct political leaders as potential saviours. Ignoring the non-scientific dimensions of the background to formulating the two degree limit, and focussing on the actions of a few elite actors, contributes to a black boxing of the two degree limit. Instead the two degree limit becomes constructed as the product of complex, unexamined scientific endeavour. Deliberation on whether there is a dangerous limit and if so, what such a limit might be is the preserve of the powerful, both politically and scientifically. The absence of any rational criticism of the idea of a two degree limit (the criticisms from some developing country leaders being quarantined by comments from western leaders about 'unhelpful' language and comparisons to the holocaust), and a focus on disputes about emission cuts, leaves the two degree limit intact and untarnished by these intense negotiations. Even discussions of the European heat wave as a dangerous event which will become the norm under two degrees of warming is not seen as reason for rejecting the two degree dangerous limit.

The focus on economic institutions is reflected in the named actors to which the media refers, with Sir Nicholas Stern being the most cited named expert. Such discourses have something of a gate-keeping function, confirming that climate change is an issue to be addressed within the existing capitalist economic system that defines these institutions. This perspective is strengthened by a focus on the work of Stern, who frames climate change within a standard cost-benefit analysis which defines capitalist responses to risk. As we have seen repeatedly throughout this analysis, the subject which named and anonymous experts are called upon to discuss is not the two degree limit, but the emission cuts needed to avoid more than two degrees of warming.

Qualitatively we can outline some initial impressions from this discussion of how the media uses institutions to support the idea of a two degree dangerous limit?:

- News reports treat the institutions as authoritative sources of information, whilst in interviews a much different picture emerges of the nature of the debates within these institutions on the setting of a dangerous limit. Whilst the reports quoted are interpreted as definitive statements about future climate change impacts, interviews hint at a contested

process behind the production of these reports. This issue is revisited in the third section of the analysis.

- There is a focus on the agendas of those institutions working in the global North. Reporting on the work of these institutions does not include any critical engagement with the validity of the two degree target. What disputes are discussed are focussed on the relevant emission cuts needed to avoid more than two degrees of warming. Discussion of institutions from the global South (the G77) provides the only instances of challenges to the two degree limit.
- Overall, agreement on the two degree limit is seen as a positive step. The battle is to agree the necessary emission cuts for achieving this goal.

Chapter 7

The Two Degree Limit

7.1 Introduction

The first chapter of this analysis focused on indentifying what individuals, groups, institutions and events were present in discussion of the two degree limit. Discussion of the two degree dangerous limit through reference to these actors and events was predominantly a feature of news report documents. The data revealed a privileging of elite perspectives on the dangerous limit debate, mainly from economic institutions and policy actors. Such contestation as arose was focussed predominantly on questions of climate sensitivity, though there was occasional mention of the perspective of Annex 2 countries on the justice of the two degree limit.

In this second section of the analysis I am interested in answering three questions:

i. Is there a consistent description across the document families of what levels of warming are dangerous?
ii. Is there a consistent description across the document families of what impacts are considered dangerous?
iii. Is there a consistent description across the document families of the relationship between warming and the manifestation of these impacts?

The simple statement "Two degrees of warming is the dangerous limit" is responded to in several different ways in my data:

a) There is no dangerous limit because there is no anthropogenic forcing of the climate. Any changes that may be occurring are natural and it is meaningless to impose the idea of a limit on those changes as they are beyond human control or intervention.
b) There is no dangerous limit because all anthropogenic forcing of the climate is dangerous. Instead there is a continuum of increasing danger.[91]
c) The two degree limit means dangerous climate change does not begin until that limit is exceeded, by however small a margin. In these accounts two degrees of warming itself is not dangerous, it is only once we go past two degrees that we begin to experience dangerous climate change.

[91] This is different to Harvey's work on dangerous anthropogenic interference with the climate (2007a,b). Harvey's work defines dangerous interference as that which raises beyond a negligible probability the chance that human activities will generate dangerous impacts. Here I am just looking at what impacts are or are not constitutive of dangerous climate change.

d) The two degree dangerous limit means dangerous climate change begins at two degrees of warming. In order to avoid dangerous climate it is necessary to stay below two degrees of warming.[92]

e) There is a dangerous limit, it cannot be identified exactly, but is thought to be around the two degree mark.

f) The impacts arising from all warming scenarios up to and including two degrees are treated in an homogenous and differentiated manner.

I ignore (a) because my interest is in those discourses which, having accepted the existence of anthropogenic forcing of the climate, go on to impose ideas of a dangerous limit on to this phenomenon. I take (c) as the most literal representation of the two degree limit idea. This category is analysed as one separate body of quotes. The codes for (b), in accepting anthropogenic climate change but in rejecting the idea that this process has a dangerous limit are analysed as another separate body of codes. (d) is the most populous category, and includes several different approaches to making similar claims about dangerous climate change. I treat the quotes for (f) as confused and confusing descriptions of the dangerous limit idea.

As well as examining what levels of warming are associated with descriptions of danger, I also compare descriptions of what impacts are considered dangerous. Additionally I discuss how ideas of rapid change or thresholds are mapped on to descriptions of dangerous climate change.

Table 10 outlines how I have split these codes for the purpose of analysis. The "Dangerous above two degrees" category describes the quotes in (c).[93] My research was in part informed by the sense that dangerous limit discourses predominantly took the form of (c). This assumption does not, at first glance, appear to be borne out by the data, which shows a far greater number of quotes describing the limit as something other than two degrees than those identifying two degrees as the precise line between safety and danger. The word "threshold" refers to the idea that there is a point at which the climate system, or elements of it, change

[92] This is a distinction highlighted by Lowe and Lorenzoni, who interpret the EU call to stay below two degrees as a different approach to the dangerous limit than calls, such in the Copenhagen Accord, to not go above two degrees:

> 'Various organisations argue that temperatures should be kept well below the 2^{o}C average (above pre-industrial levels) as this could already result in adverse impacts to human and natural systems or rapid irreversible changes. For instance, the European Union Environment Council Decision of 1996 proposed that temperature increases should not be allowed to exceed 2^{0}C and concluded that CO2 concentrations should be kept below 550 ppmv'
>
> 2005: 10.

[93] These quotes share some conceptual ground with the "Thresholds" quotes except that the latter, whilst referring to the idea of sudden and dangerous change, do not always identify that as lying at two degrees. They are therefore analysed as a separate body of quotes.

rapidly. Such changes are normally coupled with earth surface changes. An example of this might be melting of permafrost, leading to large releases of methane gas, which further accelerate climate change in a positive feedback loop.

Table 10: Two degree limit code categories.

Code categories	*Number of quotations*
Limit as other than two degrees	197
Thresholds	126
Impacts	88
Dangerous above two degrees	79

Within the "limit as other than two degrees" category there are contradictory codes, some for quotes describing the limit as greater than two degrees, others describing the limit as lower, other arguing two degrees itself is a dangerous amount of warming. I therefore do not attempt an overview of the "limit as other than two degrees" category as a whole, but break the analysis down into separate sections, as shown in *Table 11* below.

Table 11: Codes for the 'limit as other than two degrees' category.

Codes	*Number of quotations*
Keep below two degrees	60
Two degrees and below treated as one category of impacts	31
Dangers at two degrees exactly	40
Already dangerous	33
Not really a limit	27
Around two degrees	8

7.2 Keep below two degrees

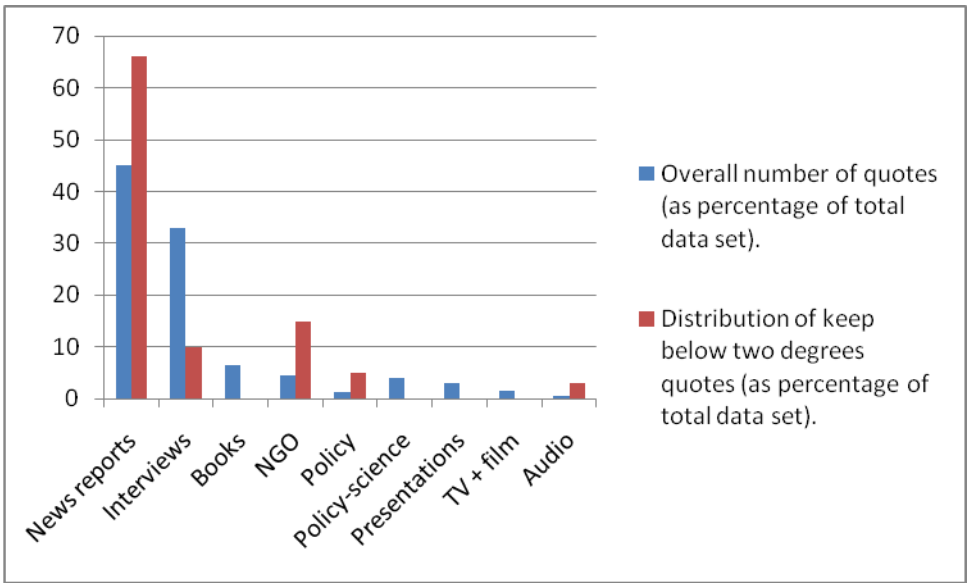
The sixty quotes in this category show a weighting towards the news reports document family, which provides 66% of these quotes against 45% of quotes overall (*Figure 13,* below). Data for the policy/science, presentations, TV/film and book document families did not contain any "Keep below two degree quotes". There is no immediately apparent explanation for this pattern. NGO documents are over-represented, providing 15% of the quotes. Interviews are

under-represented, providing only 10% of the quotes. This represents the nature of the interview event, where I am asking knowledgeable actors to provide detailed accounts of the genesis of the two degree limit, rather than asking them to plead for a particular limit to a wide lay audience.

Two quantitative patterns emerge if one drills a little deeper into the data. I collapsed three codes into this one for the purposes of this analysis. The major one, providing 50 of the 60 quotes, was "Keep below two degrees".

There were also two smaller codes - "Keep as far below two degrees as possible" (4 quotes) and "Two degrees is too much" (6 quotes). All of the latter quotes came from interviews, and all the former from NGO documents.[94]

Figure 13: Distribution of 'Keep below two degrees' codes.



The claim that it is necessary to keep below two degrees leaves a number of questions unanswered, such as whether the need to keep the global temperature to below two degrees means 1.9 degrees of warming is okay. Further, is to argue for anything below two degrees to refuse to attach any significance to the difference in impacts between say, 0.7 degrees of warming and 1.9 degrees of warming, or to assume 1.9 degrees of warming is very different from two degrees of warming?

An alternative "below two degree limit" is articulated in media reports of developing nation calls for a 1.5 degree dangerous limit. Fourteen mentions of the 1.5 degree target were

[94] It is worth mentioning that one of the books analysed had the title '2 degrees too high' (Arthus-Bertrand 2009). My analysis has been of the text inside books, and has not included the titles. This book was not identified as a source for quotes to keep below two degrees as the book actually argues for a two degree dangerous limit (89).

identified in my data. Four of these instances came from one interview with a climate campaigner from WWF, and seven from the news report document family, all in stories from the Copenhagen summit.

The prominence of the "Keep below 2 degrees" code in the newspaper family can in part be explained as the consequence of the media's reliance on the opinions of elite actors and institutions, as identified in Section 1 of this analysis. The need to stay below two degrees is the approach found in most recent policy pronouncements from western institutions[95]:

> The swift transition to a global low-carbon economy is therefore the central pillar of the EU's integrated climate change and energy policy in order to reach the EU's objective of keeping global average temperature increase below 2°C compared to pre-industrial levels.
>
> Green paper from the Commission to the Council, June 2007

> Leaders of all major emitting countries reiterated the importance of keeping the increase in average global temperature below 2 degrees Celsius, as recognised by the G8.
>
> Chair's Summary, G8 Communique, L'Aquila, July 2009: 5

> To achieve the ultimate objective of the Convention to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius, on the basis of equity and in the context of sustainable development, enhance our long-term cooperative action to combat climate change.
>
> UNFCCC Draft decision/CP.15 Copenhagen Accord, December 2010

Expressions of the need to stay below two degrees which appeared in news reports were normally expressed through the words of particular actors or conference outputs. However, there were also instances of the media source providing editorial on this issue:

[95] But see 2610th Council Meeting Environment Luxembourg, 14 October *(*2004: 12) and Europa (2007) for examples of the EU setting the limit at up to and including two degrees of warming.

> "The increase in global temperature should be below two degrees." This will disappoint the 100-plus nations who wanted a lower maximum of 1.5C, including many small island states who fear that even at this level their homes may be submerged.
>
> *The Guardian*, December 19th 2009

> Oxfam International's climate adviser, Hugh Cole, said: "At this stage, a deal that fails to keep temperature rises below two degrees is simply not good enough".
>
> *The Guardian*, December 18th 2009

> Staying this side of two degrees is the most urgent cause of our time. But why couldn't we even get agreement on that?
>
> *The Independent*, June 11th 2007

> However, key states, including the US and China, reached what they call a "meaningful agreement" on a number of issues, such as a recognition to limit global temperature rises to less than 2C.
>
> *BBC News Online*, 5th January 2010

Where NGO documents echo the call to stay below two degrees, there is a tendency to stress the need for staying well clear of the dangerous limit:

> This paper explains why global average temperature rise must be kept as far below 2°C as possible (from pre-industrial levels), based on a review of evidence of the impacts at different temperature ranges.
>
> Tearfund. Two Degrees One Chance, May 2007

> Delaying significant actions by even 5-10 years undermines our ability to stay well below 2°C.
>
> Climate Action Network Europe, February, 2010

My data includes fourteen references to what “well below two degrees” might mean. Six of these came from the print media, and one from a news broadcast on BBC Radio 4. In all these media sources the target was 1.5 degrees:

> He led the "1.5 group" - a collection of island nations that will drown if the temperature rises by more than two degrees. [96]
>
> *The Sunday Times*, February 28th 2010

> The victims, who make up the majority of the countries present in Copenhagen, are convinced that only a 1.5 degree increase could save them.
>
> *The Daily Telegraph*, December 12th 2009

> Two numbers are crucial here: 1.5 and 350.
>
> *The Independent*, December 12th 2009

I identified only one claim for a lower than 1.5 degree target, in a report written by Bill Hare for an NGO:

> It would seem safest and most prudent to reduce emissions fast enough in the coming decades so that global warming can be stopped soon and as far below 2 degrees Celsius as possible. The warming would then also need to be reduced as rapidly as possible, aiming to get it below 1 degree Celsius above preindustrial level.
>
> Hare, 2009: 21-22

A senior WWF climate campaigner interviewed for this research saw calls for a 1.5 or lower limit as politically motivated, and was suspicious of such calls:

> And I assume you've been following the debate around 1 degree and 1.5 deg and sort of what's been going on recently its actually in the Copenhagen accord there's a reference to 1.5 degrees and more recently in the Bolivian meetings that they're having Eva Morales has said the goal should be 1 degree. I think you'll find not all countries are taking these positions in good faith. The countries that are taking really, really ambitious positions are doing so because they know them to be impossible and they know they will completely stall and breakdown negotiations all together. So there are countries for example within

[96] In fact their fear is that their islands will drown if temperatures rise by more than 1.5 degrees, hence their campaign objectives.

> the climate negotiations that will say "you know, we want 10% in GDP to go to climate science and we need an 80% in emissions from all developed countries within the decade". Now some people might characterise that as very, very ambitious, and other might people might characterise that as an attempt to torpedo the process because it's such an ambitious aim that it's impossible, probably both politically and physically. And so you have that dynamic within the temperature debate in the negotiations as well. To what extent does Bolivia really care about limiting warming to 1 degree and to what extent are they fed up with a global economy focussed on capitalism which is most of what you hear Morales talking about?
>
> Campaigner 11

The idea of anything below two degrees as politically charged was implicit in this UK academics' comments:

> I think demonstrating that effectively that you can stay under that limit would be a big achievement because as I said it would involve a radical rethinking of the way we operate not obviously as radical as potentially you know a 1.5 target but I still think it would be quite significant.
>
> Science/policy academic 3

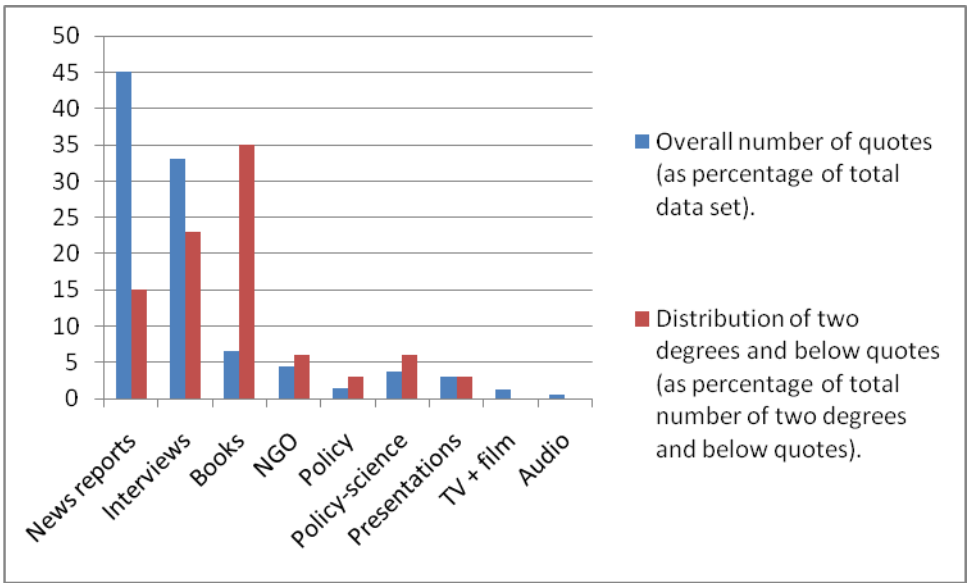
7.3 Two degrees and below as one category of impacts

In contrast to calls to keep below two degrees in order to avoid dangerous climate change, I identified thirty one quotes that did not differentiate between impacts up to and including two degrees of warming, and instead argued that dangerous change may be apparent below two degrees of warming.[97]

The most telling pattern in *Figure 14* is the distribution of quotes between the newspaper and book document family. The news report document family, as has already been shown, privileges simple elite descriptions of two degrees as a dangerous limit. The book document family provides a more nuanced treatment of the issues.

[97] Elsewhere I discuss quotes that claim that we are already living with dangerous climate change. These are different from the quotes analysed here, which still project dangerous climate change as something that will arise in the future.

Figure 14: Distribution of quotes for the 'Two degrees and below' code.



Within the book document family the likely impacts below two degrees of warming are given quite detailed treatment. These descriptions indicate a range of negative impacts at warming of up to and including two degrees of warming.

Mark Lynas (2007), in a book which collated scientific research to spell out impacts at various levels of warming makes the following claims:

> Warming of 2 degrees or less means large areas of the Southern Oceans and part of the Pacific will become effectively toxic to organisms with calcium carbonate shells after about 2050. As they die less and less $C0^2$ can be absorbed by the ocean, increasing acidification. (60)

> A climate 1-2 degrees warmer than today could melt enough of the Greenland ice sheet to drown coastal cities around the globe. (72)

King and Walker also adopted a similar undifferentiated approach to describing the impacts that might arise from different warming levels, up to and including two degrees:

> Vulnerabilities at warming of up to 2c
>
> - Global crop yield will be higher than today but this masks an inequality. In some middle and high-latitude countries crop yields go up, but in the tropics they are already falling. 10-30 million more people at risk of hunger.

- Increase in human health problems from heat waves, malnutrition, floods, droughts and spread of infectious diseases.
- Less water availability and more drought in the middle latitudes and semi-arid tropics. 0.4-1.7 billion people suffering increased water scarcity.
- Environmentally driven migration with the potential to exacerbate conflicts over scarce resources and cultural invasions.

2008: 91

My data reveals widespread recognition that avoiding more than two degrees of warming does not necessarily mean avoiding dangerous climate change:

> I don't think we've necessarily been successful in explaining to people that ahead of 2 degrees there are also going to be significant issues worldwide and I think that's a failure of the NGOs to talk about actually we are already seeing and will see some significant impacts on the poorest parts of the world.

Campaigner 1

> I think there are still uncertainties in the climate system and our understandings of it that might potentially indicate that reaching the 2 degree target might be quite late in effect because there might be unforeseen consequences which might take place even below that target.

Science/policy academic 3

> Just because you've limited warming to 2 degrees if you can get to the point where we can actually achieve doesn't mean you not still going to have really devastating impacts of climate change.

Campaigner 10

> My understanding is that the kind of changes that would happen that under 2 degrees or under and up to 2 degrees don't sound like they there are things I want to happen. I don't want the world to go to 2 degrees.

Campaigner 5

It's going to be dangerous below 2 degrees and its going to be really dangerous above 2 degrees so numerical framings are ok but just don't get too anal about it.

Climate scientist 2

Even the most modest predictions of a 1 degree C rise will see some irreversible damage to the tree coverage.

The Daily Telegraph, March 12th 2009

A one-degree rise is bad but inevitable; two degrees would be worse; three catastrophic.

The Guardian, December 10th 2009

An increase of one or two degrees centigrade begins to have a devastating effect.

The Guardian, February 19th 2004

It is increasingly recognised among scientists and others that limiting temperature increase to 2^0C will not necessarily avoid severe regional, and possibly global, impacts.

Baer and Mastrandea, 2006: 9

All this says is that even by 2 degrees Celsius we will already be seeing some adverse affects on food, water, loss of ecosystems, increase in extreme weather events.

Watson, Darwin lecture, 14th March 2010

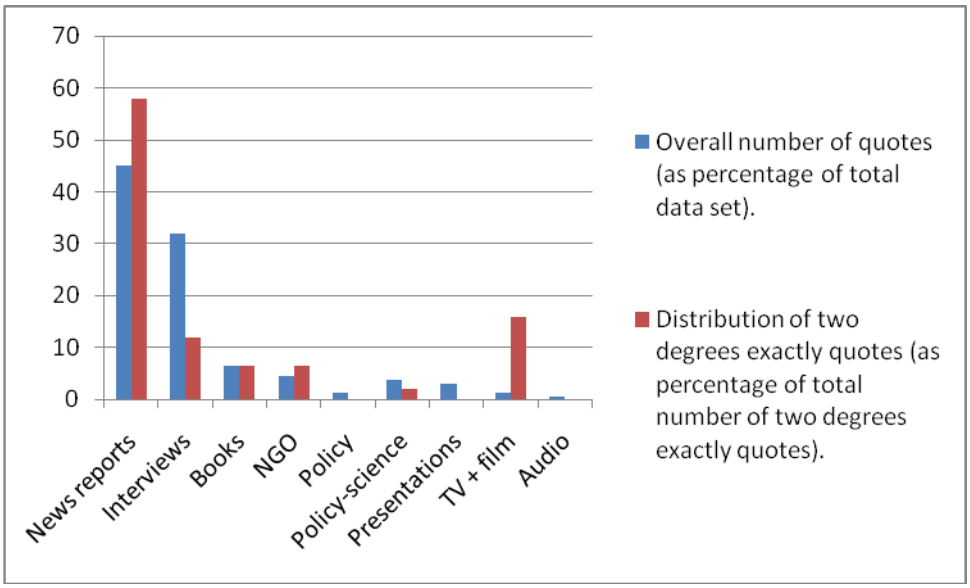
In summary, although a 2^oC rise in temperature above pre-industrial remains the most commonly quoted guardrail for avoiding dangerous climate change, it nevertheless carries significant risks of deleterious impacts for society and the environment.

Richardson et al., 2009: 16

7.4 Dangerous at 2 degrees exactly

I identified forty one quotes suggesting that dangerous climate change begins at the two degree mark. As *Figure 15* shows, such representations of the relationship between impacts and two degrees of warming are weighted towards the news report and TV/film document families[98], but less prevalent in interviews. This is in line with expectations of broadcasts providing an account of the two degree limit which does not accord with how well-informed actors describe the relationship between warming and dangerous impacts.

Figure 15: Distribution of 'Dangerous at two degrees' quotes.



Media reports and TV and film tend to frame the discussion of warming and impacts in terms of discrete units; x will happen at 1 degree, y will happen at 2 degrees, z will happen at 3 degrees and so on:

> Pachurai : A 2 degree increase in temperature will make life very, very difficult on this planet. A 2 degree world doesn't look very good. I mean with 2 degrees we will certainly get very high sea levels over a period of time.
> Narrator : New York - In a 2 degree warmer world it is predicted that this city is more likely to suffer from catastrophic flooding because of a storm surge caused by a hurricane.

[98] Though most of the quotes for this code (five out of a total of six) came from one BBC documentary, which repeatedly equated two degrees of warming with a range of different impacts.

Narrator : In a 2 degree warmer world fire, the spread of deserts, heat waves or droughts will become more commonplace and for some people the extreme effects of temperature increase will become a matter of life or death.

Hot Planet, BBC 13th December 2009

According to climate change models, a two-degree rise in global temperatures could cause a collapse of the Greenland ice sheet and dangerously high sea levels by the end of the century.

The Guardian, July 6th 2007

A rise of two degrees will be tragic.

The Guardian, March 12th 2009

Two degrees is dangerous.

The Independent, November 28th 2005

Two degrees is the point of no return, and we're about to hit it.

The Independent, October 20th 2008

"In my whole business career, I have never seen a more misleading public statement," commented the CEO of WWF Australia Greg Bourne, formerly a senior executive with the oil and gas company BP. "If the statements made today become a reality, this will lock us into a four degree [Celsius] rise in global average temperatures, when two degrees is considered extremely dangerous."

BBC news online, December 1st 2006

Recent scientific research tells us that if the average global temperature rises by just 2°C above the level recorded in pre-industrial times, the consequences for people and nature will be devastating - as many as 30% of all species of animals and plants could be lost, up to 40% of the Amazon rainforest could die back this century, and many of the world's coral reefs will perish. Millions of people, particularly the poorest people in vulnerable areas, will also be at risk. And that's with just a 2°C rise in temperature!

WWF, Tackling Climate Change, 2009: 4

> Such change has occurred at only 0.7°C of warming. One can only imagine how catastrophic climate change will be at 2°C of warming above pre-industrial levels.
>
> WWF Pacific.org, 2003: 3

> An accumulation of disconnected factors could lead to sudden system breakdown. A temperature rise of two degrees is predicted to be sufficient to cause that.
>
> *The Daily Telegraph*, October 7th 2006

> Almost all climate scientists now agree that two degrees of global warming would trigger off catastrophic climate change, with the potential to displace hundreds of millions of people.
>
> *The Observer*, October 29th 2006

A more nuanced approach appeared in the few interviews conducted with campaigners and researchers in this field where two degrees was described as dangerous. Here the two degree limit was seen as dangerous because of the interactions with other factors such as pollution and habitat loss:

> It is very likely we will not see the type of reefs we see today in a world of 2 degrees plus acidification plus overuse and so on. But it is not true that all the reefs are going to go and no one is going to say this because reefs change and a lot of the, well I am not an expert in these things, but a lot of the typical ecosystem types you have today they will probably look a lot different under a 2 degree future. There will be fish left but of a whole different type, probably a whole lot less diverse.
>
> Policy/science academic 6

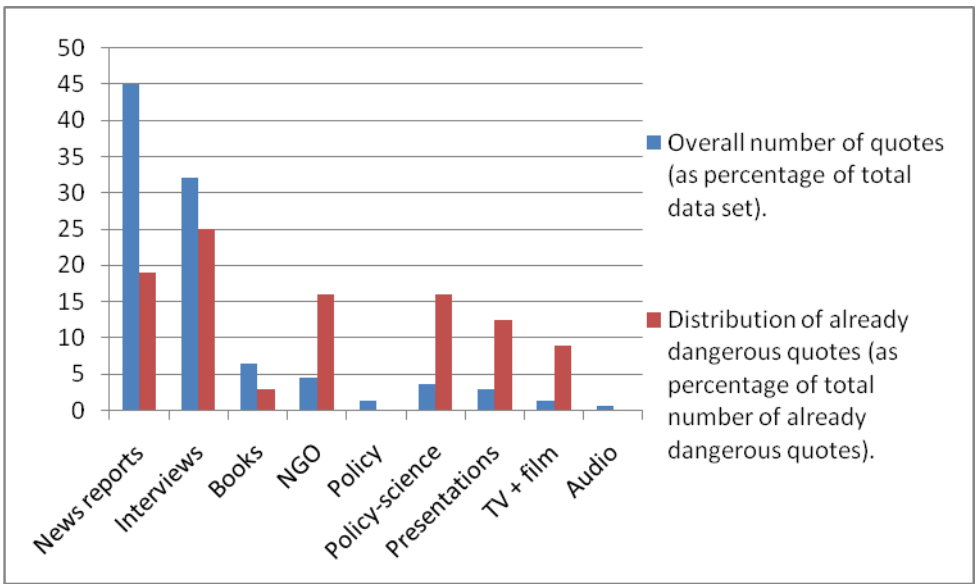
7.5 Already dangerous

Previously we have seen that some narratives project significant climate change impacts occurring below two degrees of warming, whilst still positioning dangerous impacts as yet to

appear. The 34 quotes I analyse in this section claim that dangerous climate change has already begun.

Figure 16 shows fewer quotes from the news reports document family for this code than the overall average proportion of quotes provided by news reports. These quotes are over-represented in several other document families. It is reasonable to expect, given the sensitivity to environmental risks associated with this discourse community, that NGOs would stress evidence which lends credence to calls for urgent action.

Figure 16: *Distribution of 'Already dangerous' quotes.*



The presentations analysed in this thesis are often keynote expert analyses delivered to a knowledgeable and potentially critical audience. One would anticipate such presentations to stick closely to the robust and most recent evidence. Again, the theories informing this thesis would therefore lead to the expectation that descriptions of dangerous climate change as not limited to two degrees of warming would predominate in this document family. The policy/science documents similarly need to be based on high standards of research. Therefore, as for presentations, one would expect acknowledgement of the problems with attributing danger to a distinct two degree threshold.

Campaigners, campaigning documents and other actors who have taken an advocacy role largely looked to impacts on the poor to justify claims that climate change has already reached dangerous levels:

> We have gone to places like Kenya and drier areas of the world and talked to the people and it's the biggest drought they've ever seen and the people are quite up against it already.
>
> Campaigner 5

> Many of the world's poorest people and most fragile ecological systems are already being forced to adapt to dangerous climate change.
>
> UNDP Human Development Report, 2008: 14

> I think if there were discussion about it there would be sense of that and certainly there would be in the Arctic communities who are already being affected by massive climate change. And I can imagine them saying "what are you talking about safe, it is already past the point of no return for us. You guys may be talking about what is safe for you, but it happened quite a few years ago for us."
>
> Campaigner 3

> Somebody whose existence depends much more on subsistence use of climate sensitive resources would see themselves in that way and are already experiencing climate change at today's levels some way below 2 degrees c and see their livelihoods being threatened.
>
> Climate scientist 4

Acceptance of the belief that climate change has already reached dangerous levels leads to arguing for targets which at least limit the amount of danger. These narratives are in essence describing another limit, dividing one level of danger from another, more serious level of danger:

> We would actually describe the climate change we are experiencing today as dangerous. If you look back at the actual UNFCCC the objective was to avoid dangerous climate change and I think there's general political agreement now that it's too late for that, we have dangerous climate change. I think there's a political realisation, certainly within the current US administration that what we are experiencing already is dangerous and the goal of limiting warming below 2 degrees is meant to try to contain that danger as opposed to prevent danger.

Campaigner 11

> We're already in the "dangerous impacts" zone of global warming with drought, glacial water loss, heat waves, etc., but the dangers we're trying to avoid with 350 are the ones we can't normalize further down the line. There's no bringing back the Greenland ice sheet once it goes.

Campaigner 6

> There are real damages associated with 2 degrees and it's a legitimate thing to say that you don't want to experience the damages above 2 degrees. And so at 1.8 degrees of warming the world is not well off at all. It is twice as bad as it is now and at 2.2 degrees the world does not become a climatic pumpkin. It's too late to prevent dangerous change but not to prevent very dangerous change.

Climate scientist 2

> Many previous attempts to decide how far we should allow our climate to go began with the idea that we should stop climate change before it becomes "dangerous". However, it's too late for that. A better question is how much climate change can we afford before things become truly catastrophic.

King and Walker, 2008: 90

> Two degrees, because it has been widely recognised by climate scientists as the critical threshold has sometimes been characterized as a "safe" level of warming. As I hope this account has shown, it is merely less dangerous than what lies beyond.

Monbiot, 2006: 15

Schellenhuber, the lead author of the WBGU reports, delivering the keynote speech at a conference in Oxford in September 2009, argued that because of other deleterious environmental issues, climate change was already threatening dangerous impacts:

> This is not just about climate change as one of the environmental spaces where we need to think about boundaries, but also there are eight other boundaries. And it actually turns out that for three of the nine of the sectors, if you like, we are beyond the boundaries as a scientific community where we

> think this is too dangerous to venture into that terrain. We even come up with numbers, which will be debated fiercely of course, but that's the idea, but on climate change, on biodiversity loss and on the nitrogen cycle we clearly are in the red zone already. So in the end this is a good political compromise but if you look at the recent research that was published in PNAS this year by Smith and others. This is the stark evidence that 2 degrees is certainly not a very good line.

7.6 Not really a limit

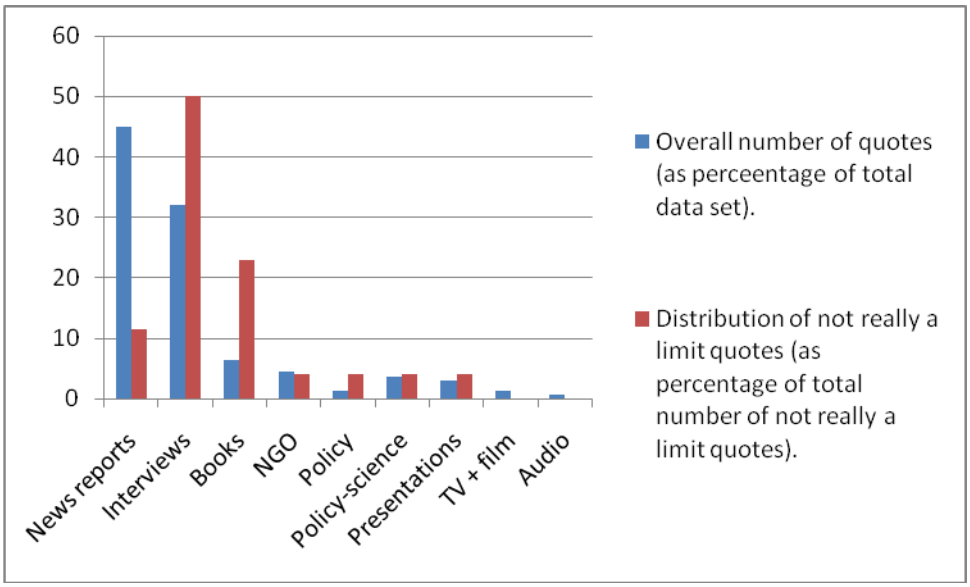
These following quotes deny the existence of distinct limits or thresholds between one condition and another, but instead argue for a continuum of ever increasing danger, which begins the moment human activity interferes with the climate.

There were only 26 quotes in total for this code. The theoretical approach adopted in this thesis rejects the idea of a distinct temperature increase which separates safe climate change from dangerous climate change, and it was anticipated that there would be few quotes in the broadcast commentaries reflecting this belief. The elements of elite theory and institutional theory most germane to this research argue that the defining of a two degree dangerous limit to climate change reflects a desire to reproduce and protect the legitimacy of current industrial practices. The idea that it is not possible to separate safe from dangerous climate change is a challenge to those goals. As shown in *Figure 17* (below) there are many fewer quotes in the news report document family than the average for this document family. Instead the quotes are weighted towards the interview document family.[99]

The weighting of these quotes towards the interview document family results from knowledgeable actors being asked direct questions about the issue in a less time constrained setting. The suggestion that given the space and a knowledgeable audience it is possible to explore the difficulties of identifying a dangerous limit also explains the relatively large number of these quotes in the book document family.

[99] In fact there were only two quotes from the NGO document family.

Figure 17: *Distribution of 'Not really a limit' quotes.*



The two campaigning voices identified in my sample which refuted the notion of a discrete limit were both associated with groups whose work includes engagement with people from Annex 2 countries:

> I don't think WWF would take the position that it's safe below 2 degrees and dangerous above 2 degrees.[100]
>
> Campaigner 11

> There is no hard-and-fast line separating "dangerous" from "safe" climate change.
>
> UNDP Human Development Report 2008: 10

Voices from the Annex 1 countries sought to define a dangerous limit with reference to the IPCC "flaming embers" diagram:

> I think this is a fair way of doing this picture, where it shades gradually from where we were to where we think it would be pretty disastrous at 5 degrees

[100] Attempts such as these to distance oneself from claims of a two degree dangerous limit appear elsewhere in the data. In this instance the claim that the WWF would not claim that two degrees is a dangerous limit is not supported by the documentary evidence. For example the Christian campaign group Tearfund released a report in 2007 called 'Two degrees, One chance'. The report was endorsed by 34 different agencies including the WWF Climate Change programme and includes such statements as '2°C is a clear limit that cannot be exceeded - the world must act with urgency' (p1). See also WWF 'Tackling Climate Change, 2009: 4.

on the right hand side and a Met Office version trying to simplify it for politicians. But the words when you come down to it still say "some marine ecosystems suffer irreversible change" we know things are going to get a lot worse as we go towards that end but the way we demonstrate that and the confidence with which we say that is difficult to really put down.

Hoskins, keynote conference presentation, September 2008

It is clear from this overview that substantial risks, dangers, and damages are likely across multiple sectors should global temperatures warm 1.5-2 degrees Celsius above the preindustrial level. Risks of extinction and major ecosystem disruption are evident at the low end of this range and increase rapidly with the rising temperature.

Hare, 2009: 13

In terms of you look at tables that certain people come up with about what sort of impacts we will have at that 2 degrees, that the sea rise, ice sheets melting, desertification, drought, flood that kind of thing, I don't think necessarily 2 degrees is necessarily the point when that suddenly starts to happen.

Policy/science academic 1

A lot of people, including Martin Parry, wanted us to be very specific on the thresholds at which these things are triggered and I said we can't do that. The reason we have words stretching out over a fair amount of space is because there is some literature suggesting the thresholds are irreversible or unfixable damage are very low, other literature is in the middle and some literature is at the high end, so all that we can say is that the more you increase the pressure on the systems the more the number of the systems which will be at risk and the more intense those risks will be. So what you end up doing you end up in the kind of cliché I have which is the more you do the increasingly more you damage.

Climate scientist 2

This idea of ever increasing risks, starting the moment warming begins, was the most common theme, though in almost all instances the two degree marker was seen as a significant line in this continuum:

> Beyond the 2°C level, the risks to human societies and ecosystems grow significantly.
>
> International Climate Change Taskforce, 2005: 9

> If temperature rises exceed 2°C compared to pre-industrial times, the risks of major, irreversible changes and feedback effects increase.
>
> The UK Low Carbon Transition Plan, July 2009: 31

> As the temperature rises, more and more serious phenomena appear in the scenarios.
>
> Arthus-Bertrand, 2009: 89

> 2^{o}C, it's not a dramatic threshold above which something bad would suddenly happen. Rather it's like a speed limit in that the higher you go above 2^{o}C the greater the risk of a serious disaster
>
> King and Walker, 2008: 99

7.7 "Around" the two degree limit

I identified eight instances where the danger was said to reside "around" the two degree limit. Five of these quotes came from the news report document family and two from the policy/science document family. The low number of quotes which accept such ambiguity further reinforces one of the emerging patterns in this data, namely an aversion in broadcast documents to uncertainty:

> At roughly 2 - 3°C above pre-industrial, a significant fraction of species would exceed their adaptive capacity and, therefore, rates of extinction would rise.
>
> Stern Report, 2006: 293

> (Lord Turner's) climate change report, published yesterday, is long, detailed and impressive. It has the admirable objective of trying to cap global warming at two degrees or a little more.

The Guardian, December 17th 2008

> "Current pledges point in the right direction, but fall short of what is needed to keep the global temperature rise to around two degrees Celsius above pre-industrial levels,'' Mr Tanaka said.

The Daily Telegraph, December 15th 2009

> The idea alarms other scientists, who fear such a massive input of sulphur into the upper atmosphere could increase acid rain or damage the ozone layer. Crutzen believes his idea may still be necessary if Earth continues to warm up at its current rate. "I am prepared to lose some bit of ozone if we can prevent major increases of temperature, say beyond two degrees or three degrees," he says.

The Observer, October 29th 2006

> The threshold for dangerous climate change is an increase of around 2°C.

UNDP Human Development Report, 2008

> The threshold from which damage to the global natural heritage is no longer acceptable cannot be determined precisely. However, the WBGU estimates it to be in the range of 2°C global warming relative to pre-industrial values.

WBGU, 2003: 1

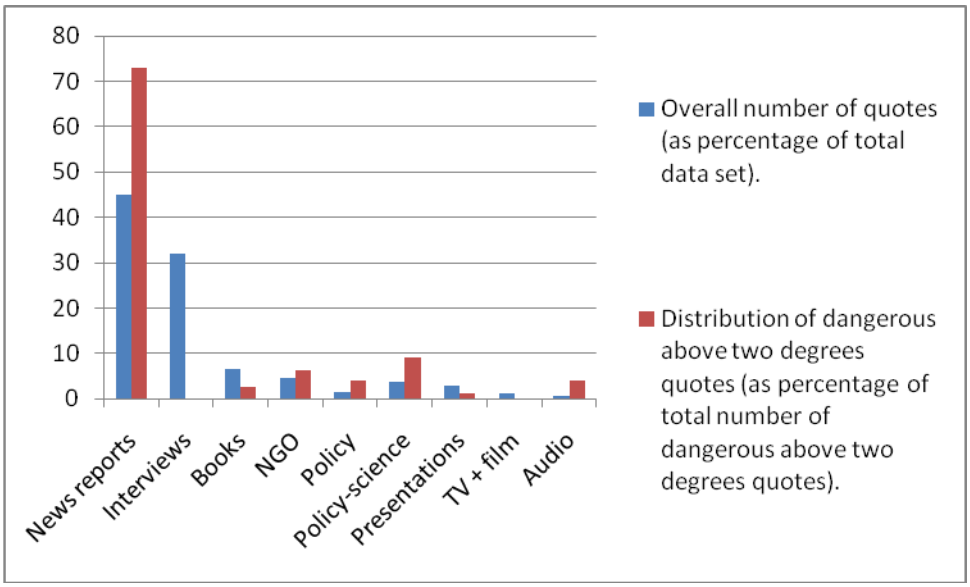
I now compare the data analysed above with quotes which argue dangerous climate change does not begin until two degrees of warming is exceeded.

7.8 "Limit as two degrees exactly" quotes

These codes are linked to quotes which allow for warming up to the two degree line, positioning danger as that which occurs once two degrees is exceeded.

The most striking thing about the distribution of quotes in *Figure 18* (below) is their complete absence from the interview family and their over-representation in the news reports, policy and policy-science document families.

Figure 18: Distribution of 'dangerous above two degrees' quotes.



This over-representation in these three document families is in line with the patterns seen previously. Newspaper reports on the subject of dangerous climate change take their cue from the words of elite actors and institutions. Policy documents and policy/science documents will inevitably adhere to the policy line which, for Annex 1 countries, is split between the idea that it is necessary to keep below two degrees of warming to avoid danger (Copenhagen summit) and that warming up to two degrees will avoid danger (EU). In interviews with knowledgeable actors, questions about how much warming is dangerous has not provided responses which accord with the policy line on this issue.

The belief that dangerous climate change is not manifest until warming has gone above two degrees is expressed in a number of different ways, as illustrated in *Table 12*.

Table 12: 'Limit as two degrees exactly' codes.

Codes	*Number of quotes*
No more than two degrees	49
Catastrophe above two degrees	9
Benefits at one to two degrees	8
Keep within two degrees	7
Dangerous beyond two degrees	6

The policy document family quotes for this code all come from the EU, which has retained a consistent position on this issue since 1996[101]:

> The Council believes that global average temperatures should not exceed 2 degrees above pre-industrial level.
>
> 1939th Council meeting, Luxembourg, 25 June 1996

> With a view to meeting this objective, overall global annual mean surface temperature increase should not exceed 2°C above pre-industrial levels.
>
> Council of the European Union, March 2005

> The Communication, a key element of the Commission's new energy and climate change strategy, sets out proposals for action by the EU and the rest of the international community to prevent global climate change from irrevocable consequences. This means limiting global warming to no more than 2°C above the temperature in pre-industrial times.
>
> Europa, 2007

The reliance of the media on political leader's statements on dangerous climate change is apparent in the following news report quotes:

> Angela Merkel, the German chancellor, who holds the rotating presidency of the G8, wants all countries to agree that the world's temperature should be allowed to rise by no more than two degrees Celsius by 2050.
>
> *The Daily Telegraph*, June 1st 2007

> We know, because Europe's political leaders told us, that a rise in global average temperature of more than two degrees Celsius is dangerous.
>
> *The Independent*, January 4th 2009[102]

[101] Though, as shown earlier, this is not the official line of the Copenhagen Accord, which instead argues that warming should be kept below two degrees. I assess the significance of this difference in the discussion section of this analysis.

[102] This sentence comes from a piece written by Tom Burke, an environmental policy adviser to Rio Tinto, a Visiting Professor at Imperial and University Colleges, London. He is also a Senior Business Advisor to the Foreign Secretary's Special Representative on Climate Change. This is one of two sentences, which read as follows: 'We know, because Europe's political leaders told us, that a rise in global average temperature of more than two degrees Celsius is dangerous. We know from our scientists that greenhouse gas emissions must be moving downwards globally by 2015 if we are to have any chance at all of staying within that limit' (*The Independent*, January 4th, 2009). This

> Mr Brown said: "The agreement at Copenhagen must be ambitious, global, legally binding within months and be consistent with a maximum global warming of two degrees and be the fairest financial settlement for the poorest countries.
>
> *The Independent*, December 15th 2009

> The Prime Minister Gordon Brown said: "I think that the academic evidence as a whole leads to one conclusion - that we've got to take action against climate change. And, I don't think there was any disagreement amongst the major countries at Copenhagen that (if we) allowed temperature rise above two degrees centigrade by 2050 - it would be very serious indeed"
>
> *BBC News online*, 25th January 2010

The next largest document family, in terms of "dangerous above two degrees" quotes, was the policy/science document family. These documents looked more to the science as justification for their position than the words of political leaders:

> There is a looming biodiversity catastrophe if global mean temperature rises above the 2°C guardrail, ocean acidification spreads and sea-level rise accelerates. These climate-related stressors will interact with a wide range of existing stressors on biodiversity.
>
> Climate Synthesis Report, 2009: 13

> In the light of evolving scientific evidence, the Taskforce recommends that emissions reductions should aim to achieve greenhouse-gas concentration levels by the end of the century compatible with limiting global average

---

distinction between policy and science on the issues of dangerous climate change and emissions reductions struck me as correct and unique in the news report document family. I emailed Tom Burke to ask him if this distinction was consciously drawn, and if so why was it important to make this distinction. For Burke the distinction is epistemologically important:

> The decision as to what does or does not constitute danger is a value judgement. As Hume famously pointed out, you cannot derive value judgements logically from statements of fact. The conclusion by scientists that different concentrations of greenhouse gases in the atmosphere have different probabilities of leading to specifiable changes in global average temperatures are all propositions that are testable against experience. There is universal agreement on what constitutes a valid measurement of gas concentrations and temperature. There is no universal agreement what constitutes danger.

> temperature rise to 2°C, and to limit the period of time during which those concentrations are above levels compatible with that goal.[103]
>
> International Climate Change Taskforce, 2005: 4

It is instructive to compare the rather dry pseudo-scientific language of these reports with the language used in NGO documents to make the case for a two degree limit.

> If global temperatures rise more than 2°C over pre-industrial levels, the climate impact on water resources, food production, sea levels, and ecosystems is predicted to be catastrophic for billions of people.
>
> Oxfam International website, 2010

> 2°C is a clear limit that cannot be exceeded - the world must act with urgency.
>
> Two degrees, One chance, 2007: 1

> If we are to save humanity and the planet from the worst mass extinction of all time, worse even than at the end of the Permian, we must stop at two degrees.
>
> Lynas, 2007: 271

The idea that dangerous change begins at more than two degrees of warming was implicitly expressed by describing impacts below two degrees, at least for some parts of the world, as beneficial:

> A slight temperature increase (between 1c and 2c) will improve productivity at high and middle latitudes. In Europe, yields could increase by 30%. The northern boundary of agriculture will move a few hundred kilometres northwards. However, increased flooding and droughts will threaten crops and maybe even create food shortages.
>
> Lynas, 2007:72

[103] This quote provides a by no means unique example of the idea of over-shoot. This approach accepts that emissions may in the short term be high enough to push temperatures above two degrees but once emissions are cut back then temperatures will drop. In this way the relationship between emissions and climate change is simplified to a model which draws its inspiration from the thermostat used in people's homes to control the central heating.

> Vulnerabilities at warming of up to 2c - Global crop yield will be higher than today but this masks an inequality. In some middle and high-latitude countries crop yields go up, but in the tropics they are already falling. 10-30 million more people at risk of hunger.
>
> King and Walker, 2008: 91

> Or what if, instead of being something to panic over, a rise of one or two degrees might have benefits that far outweigh the disadvantages?
>
> *Mail on Sunday*, November 11th 2009

> Looking at it from a purely local point of view two degrees of warming will probably be a benefit, but looking at it altruistically on a global scale it will be catastrophic for places than cannot tolerate much warming, or sea level rise.
>
> *The Guardian*, June 30th 2005

7.9 What counts as dangerous climate change?

Deciding on a dangerous limit requires agreement on what changes are to be considered dangerous. Following the pattern identified in the literature review, there is a tendency to converge on large scale, irrevocable and uncontrollable impacts as indications of danger. The supposition is that these impacts are so negative and far-reaching that there could not possibly be dissent to their definition as dangerous.[104] But at what level of warming are these large scale discontinuities to be expected? Do these commentaries dismiss those impacts which are less emphatically dangerous?

The dangers analysed in this section are somewhat qualitative. Rather than describe what things will happen at two degrees which make that amount of warming dangerous, these quotes express a fear that the changes may be either irreversible, uncontrollable, sudden or all three. This sudden change, leading to irreversible or uncontrollable change, is described as a threshold (*Table 13* below).

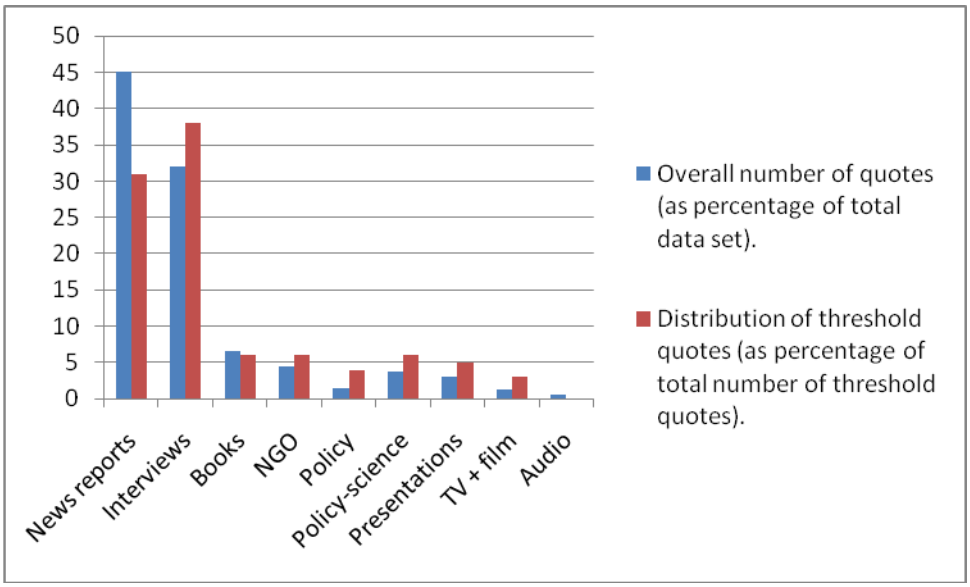
[104] See Pearce (2007a: 351-352) for an example of this reasoning.

Table 13: Codes for the 'Threshold' category.

Codes	*Number of quotes*
Threshold	40
Irreversible	18
Tipping point	17
Runaway	12
Positive feedbacks	7

"Sudden" is perhaps a strange word to describe changes which have been anticipated and worried about for twenty or more years. However, this suddenness refers to the speed with which such changes occur, once the conditions for those changes are in place.

Figure 19: Distribution of 'Threshold' code category quotes.



In *Figure 19* I have amalgamated the separate codes shown in *Table 13*. Many of the document families are present in this category in roughly the same numbers as the overall total. There is an under-representation of newspaper sources, though not as significant as in other code categories. The shortfall in quotes from the news report family is made up for in a slight over-representation in several other document families.

A more granular quantitative analysis reveals that news reports, interviews and policy/science documents together accounted for 85% of the 'threshold' quotes. The fear of "runaway" climate change was also clustered in the newspaper and interview families, providing 75% of

the quotes. 70% of "tipping point" quotes also came from these two document families.[105] "Tipping point" is similar to "threshold" in this context, but is even more emphatic. Whereas threshold can sometimes refer to the transition to a condition where runaway climate change becomes more likely, tipping point generally means an instant change with immediate dangerous impacts.

Rather than analyse on the basis of document family, if one looks at how the voices of NGO and campaigning actors are distributed across the document families one can identify a telling pattern.[106] These campaigning actors are heavily over-represented by the more emotive codes, as shown in *Table 14*.

Table 14: *Representation of campaigning and NGO voices in this section.*

Codes	*% of quotes from campaigning voices*
Threshold	27%
Irreversible	33%
Tipping point	35%
Runaway	41%
Positive feedbacks	100%

The tendency to express the dangers apparent at two degrees in such emotive terms is perhaps inevitable for those committed to broadcast the dangers of climate change in simple, quantitative terms. These descriptions equate danger with a loss of control over the climate and/or the impacts. Analysis of the data from other actors will help clarify the extent to which such conceptions are shared amongst other communities.

The word "threshold" is generally used quite freely in the newspaper reports, but with much more circumspection in other situations.

One of the board members of the Committee on Climate Change, Sir Brian Hoskins, had this to say about the notion of thresholds in a keynote speech given at an Exeter University conference on identifying dangerous rates of change, held in September 2008:

[105] Findings in my data do not support Doulton and Brown's claim that 'potential catastrophe' is the most common discourse frame for discussing climate change impacts (2007: 34). Weingart et al. also give attention to the history of the term 'climate catastrophe' in their analysis of climate change discourse in the media (2000: 274).

[106] Thus instead of just looking at news reports we look at whose voices are heard in these news reports (rather as was done in the first section of this analysis with examination of how different actors are represented in the family documents) we see that campaigners provide many of the references to threshold quotes found in the news report document family.

> We, many of us, think there are likely to be thresholds in the climate system and wouldn't it have been convenient if we knew there was a certain threshold where, if were at 499ppm CO_2, everything would be fantastic and at 501 disaster comes in. And I don't think any of us think it's quite like that. In fact, I am pretty sure it's not like that, but there may be some thresholds in the climate system. Whether you think it's the melting of the Greenland ice sheet becoming irreversible or whatever, so there may be some thresholds. They may be local thresholds or they might be more global ones, but we certainly don't know when they are going to occur so how do we build that in to our thinking? [107]

The Chair and Chief Executive of the Committee on Climate Change (CCC)[108] were interviewed by the UK Environmental Audit Committee (EAC) in February 2009, about the emission cuts recommendations they had made to the UK government. A transcript of that interview provides some insights about how decisions on emission cuts were influenced by concerns about thresholds in the climate system. In particular, members of the EAC were concerned that two degrees represented the threshold of runaway climate change. As with the conference at which Hoskins was speaking, the words of the Chair of the Committee on Climate Change indicate a willingness to accept warming of greater than two degrees. This is justified on the basis that the worrying thresholds do not appear until four degrees of warming. These discussions took place in advance of the agreement reached at the Copenhagen summit to limit warming to under two degrees:

> Q8. Martin Horwood: In common with other members of the Committee, I am getting a little nervous about this balance between 2° and 4° in your assumptions. Surely the whole nature of feedback mechanisms and the irreversibility of some of the things like the collapse of the rainforest or the ice sheets over 2° is that the thing that will increase the risk of going to 4° is actually going to 2°? Therefore, you cannot actually separate the two in the

[107] In his presentation Hoskins lamented the fact that he was the only scientist on the board of the committee. Under these circumstances his posing of the question 'we certainly don't know when they are going to occur so how do we build that in to our thinking?' becomes very relevant to this thesis. Hoskins has made clear science cannot define when these thresholds might occur, so other, non-scientific, issues are very much to the fore for the committee when thinking about where to place the dangerous limit line.

[108] The Chief Executive of the Committee on Climate Change is David Kennedy, an economist previously at the World Bank.

> way that you seem to be doing. It is almost like saying that you are going to aim to get off the toboggan halfway down the hill.
>
> Lord Turner of Ecchinswell: No, I do not think that is right. You are absolutely right to identify that one of the things you have to be very aware of-that the process of going to 2° or 3° in itself produces feedback loops which increase the chance of going to a higher level-is that those feedback loops should be in the scientific models to start with. What gets very complicated is whether there is anywhere what people call tipping points or thresholds. Does it become totally irreversible or do we simply have feedback loops without absolute irreversibility? I think that the scientists vary on that. However, we did highlight that it was possible that some of the feedback loops became very strongly reinforcing above a certain temperature and that there were some physical things which might be irreversible-melting the Greenland ice sheets, et cetera. I therefore think that we have fairly rigorously taken those into account in the way that we did it; and it was a sense of those feedback loops and irreversibility that made us believe that the crucial thing is to limit the increase to about 2 or slightly above 2; and to make very likely that we do not go above 3, and almost certain that we do not go above 4.
>
> Environmental Audit Committee transcript, February 2009

This transcript indicates that there is no scientific basis for the idea of thresholds, at two, three or four degrees. I only identified one instance of a clear rejection of the idea of a distinct threshold in the other document families:

> Undoubtedly the 2 degrees c and it being a threshold between acceptable and dangerous is very much a “social construct” of a handful of wealthy nations or the relevant people or the people who’ve made themselves relevant in those wealthy nations. I don’t think it’s got any scientific legitimacy.
>
> Climate scientist 1

Other doubts about the threshold were not so much a denial of the existence of a threshold, but rather whether it could be aligned with two degrees of warming, or indeed whether it could be identified any more clearly than lying within a particular range of warming:

> I don't think we in reality we really talk about 2 degrees we don't really talk about two degrees as a threshold, well, 2 degrees particularly 2 degrees. We've never really run a campaign saying keep below 2 degrees.
>
> Campaigner 1

> Originally the IPCC came up with a range 1.5 to 4, but basically the idea that that can be seen as a range, originally they saw it as a range. But to get more towards practice and commitment in policy terms, you can see how it makes sense to say this is more like the kind of target we have got to avoid, and treat as a threshold. So let's fix a figure and then like you say it becomes a kind of it's, it's a focal point around which everyone can concentrate.
>
> Science/policy academic 2

> Threshold is the word that I use advisedly rather than target because you hear people talk about the two degree target; threshold suggests it's something that if you cross it's a problem, it's not something you aim for.
>
> Consultant 2

One German scientist provided the exception to the pattern of responses to discussion of thresholds that arose in my interviews:

> Why have not the community of scientists earlier been clearly speaking and open speaking about this threshold and as far as I see they've majority of scientists which are probably the majority of scientists which are convinced that the level of dangerousness is in this range.
>
> Climate scientist 4

This last instance excepted, these ambiguous treatments of the two degree threshold idea are in stark contrast to how the idea is represented in broadcast commentaries. Contrary to the acceptance from the CCC that there is no scientific consensus on the idea of climate thresholds, some sources invoked science as the root of the two degree threshold for dangerous climate change:

> Two degrees, because it has been widely recognised by climate scientists as the critical threshold.

King and Walker, 2008: 12

> So my understanding is that at the time the EU adopted this 2 degree target it was certainly something that was being talked about very widely in the scientific community as a kind of safe threshold.
>
> Green Party MEP

> Scientific evidence suggests that there is a threshold of temperature increase above which the extent and magnitude of the impacts of climate change increase sharply.
>
> International climate change taskforce, 2008: 4

However, the norm is for the idea of a two degree threshold to be represented uncritically. Rather than any in-depth analysis of the reasoning behind the two degree limit, broadcast commentaries either recount the notion as fact, with its genesis black-boxed or, as we saw in the "Actors" section of this analysis, with reference to authoritative sources:

> Global temperatures should not be allowed to rise more than two degrees centigrade above natural levels, defined as the key threshold for any chance of avoiding truly catastrophic climate change.
>
> *The Daily Telegraph*, October 20th 2009

Other actors working in advocacy roles, responding in interviews, sought to distance themselves from an association with the idea of a threshold:

> The latter is regarded as essential if the world is to stay below the danger threshold of a two-degree Centigrade temperature rise.
>
> *Independent on Sunday*, December 20th 2009

> Together we demand practical action by the UK to prevent global warming rising beyond the danger threshold.
>
> Stop climate chaos website

> David Griggs, the director of the Met Office's climate research unit, explains the dangers of exceeding the "critical two degrees threshold."

The Independent, October 6th 2007

> Britain will find it 'impossible' to meet its target as part of the world's battle to ensure temperatures do not rise more than 2C - a key threshold for dangerous climate change, according to a study by a panel of leading experts.

The Observer, June 8th 2008

> The EU has defined a temperature threshold - limiting the global average temperature change to less than 2°C above pre-industrial.

Stern Report, 2006: 293

As *Table 13* showed, the idea of a threshold is defined by, or substituted with, descriptions of "irreversible" or "runaway" climate change, representing a "tipping point" or the onset of "positive feedbacks". All these terms reveal the same fear, the fear of loss of control.
News reports and campaigning actors all use similar language in their description of these tipping points. For news reports, these terms are used in story headlines, presumably to grab the reader's attention.

> Greenhouse gases are already past threshold that spells disaster; CLIMATE CHANGE: THE TIPPING POINT.

The Independent, February 11th 2006

> Earth at the tipping point.

The Observer, June 11th 2006

> No apocalypse just yet - but there are perilous tipping points around the globe.

The Times, November 24th 2009

> Two degrees is where we trigger runaway climate change: two leads to three, three to four, four to five, five to six . . . by which time it's about over for life on Earth. In other words, our elected leaders are giving us - at best - a coin-flip chance of avoiding catastrophe.

The Guardian, September 2nd 2009

> But we are running out of time - the climate may warm up by over 2c in the coming decades. If this is indeed the case the planet's different balances could be disturbed, maybe irreversibly.
>
> Arthus-Bertrand, 2009: 116

> All agree that we have to stabilise global temperatures to within 2 degrees of pre-industrial levels and the reason for that is because if you cross that threshold then there are tipping points in the earth's system which could drive the warming process essentially out of control.
>
> *Age of Stupid*, 2008

> It's the first, and possibly most important step, but we're aiming for it because it's the tipping point - the line between a solvable crisis and an unsolvable crisis.
>
> Campaigner 6

> Two degrees seems to be beyond which tipping points occur which is why 2 degrees has been chosen, if I am right.
>
> Campaigner 4

> At that point, scientists believe dangerous 'feedback loops' will trigger spiralling temperatures. This means runaway climate change, the impacts of which are difficult to predict.
>
> Oxfam website, 2009

The term "positive feedbacks" is the exclusive preserve of campaigning voices in my data set. The orientation of environmental groups towards the language of science in its campaigning activities has been noted and criticised frequently. It is this which perhaps best explains this weighting towards the pseudo-scientific concept of "positive feedbacks". One may also have to grant some fluke in the sampling process as a contributory factor. After all, if the term does not have meaning for the intended audience then there would be no value in using it. That meaning must derive from its use in other spheres, but my sampling hasn't identified this:

> But if we still have time to stabilise the climate below two degrees - and models suggest we do - then we can potentially save great swathes of global

> biodiversity, slow the melting of Greenland and associated sea level rise down to tolerable levels, and avoid the most dangerous positive feedbacks that would kick in as we approach three degrees of warming.
>
> Lynas, 2006: 270

> I personally couldn't say "this is a safe limit". I would have to go on trust of the people telling me this. It makes sense to me in terms of feedback, and, if we can stay below the level where there are feedbacks we can, we might be able to, you know, we don't get runaway climate change.
>
> Campaigner 4

> It is hard to say precisely what the dangerous level is but indications are, from evidence of positive feedbacks in the climate system, that we are in the danger zone already.
>
> Campaigner 3

7.10 Natural parameters

Though there are only a small number of quotes in this code (11) it is worth a brief, but separate discussion, because the idea of a divide between natural and unnatural conditions has been identified as being of deep cultural significance[109]. Natural is generally held to equate to the parameters of climatic variability of the last 10,000 years, itself understood as an unusually stable and benign state of affairs, as set against more geological timescales:

> One early strategy was to avoid "dangerous" climate change by keeping our warming to within the upper limits of natural variability during the relatively stable 10,000 years since the end of the last ice age.
>
> King and Walker 2008: 39

> This long term acceptable limit for absolute temperature was derived from um the, well, keeping the natural surrounding roughly intact, the natural environment is unchanged.
>
> Science/policy actor 1

[109] For example Douglas and Wildavsky (1982) and Ross (1991).

> An MEF summit in July achieved several small breakthroughs, agreeing for the first time, for example, that global temperatures should not be allowed to rise more than two degrees centigrade above natural levels.
>
> *The Daily Telegraph*, October 20th 2009

The idea of natural change is also occasionally used to question the reality of anthropogenic forcing of the climate:

> It is claimed the average temperature increased at a dangerously fast rate in the 20th century but the recent temperature rise has been between 1 and 2 degrees Centigrade per century - within natural rates.
>
> *Daily Express*, December 15th 2009

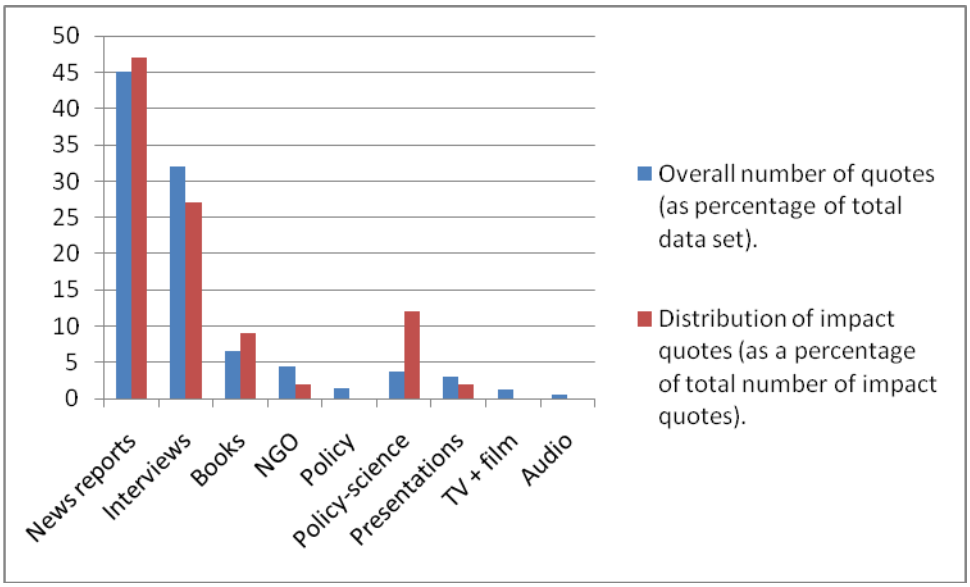
7.11 Impacts at two degrees of warming

Discussion of impacts at two degrees is split into three broad categories. Impacts are either discussed at a general global scale (32 quotes), with regards to ecosystem impacts (32 quotes) or with a focus on developing country implications (18). The final code is for quotes which describe the impacts of two degrees as survivable (6).

The purpose of analysing these codes is to understand what sort of impacts are used to support or challenge the idea of two degrees as a dangerous limit. These indicators include topics such as impacts on agriculture, health, coastal flooding, the availability of fresh water and security issues.

The policy/science document family shows a weighting towards discussion of two degrees in relation to specific impacts. These documents are attempting justify particular positions, to encourage a response from policy makers. Spelling out the issues in terms of impacts is perhaps the most effective way of communicating the perceived need for urgent action from policy makers.

Figure 20: *Distribution of 'impact' quotes.*



In this section of the analysis I want to focus on how the relationship between ecosystem impacts and two degrees of warming are represented.[110] Analysis of the commentaries on this issue reveals how the uncertainty surrounding projected climate change impacts is turned into certainty in broadcast commentaries.

The IPCC Fourth Assessment Report, published in 2007, discusses projected species loss. This report provides much of the background for discussion of ecosystem impacts that appear elsewhere:

> Approximately 20% to 30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C (*medium confidence*).
>
> Parry et al., (Eds). IPCC Fourth Assessment Report, WGII

The various caveats in the above IPCC statement communicate a sense that the possible ecosystem impacts have been successfully quantified. A recording of a presentation given by DEFRA's Chief Scientific Advisor, and former chair of IPCC WGII offers an insight into what the probabilities in that statement actually mean:

> So what is it we are actually project? Well, what we project is an increasing number of ecosystems are likely to be disrupted by a temperature rise of more

[110] The other area of interest, how the descriptions of two degree impacts differentiate between impacts on Annex 1 and Annex 2 countries, was largely addressed in the analysis of media coverage of the Copenhagen summit.

> than 2 degrees rise above pre-industrial. For every 1 degree rise above current temperatures we lose 10% of species. So if we do see a 5 degree rise the projection is a 50% loss of species. How good that number is I don't know, but whether it's 50%, 40%, 30% or even 20% that's a major extinction of species. So even if we were wrong that it's not 10% for 1 degree rise that it was 5% or 3% that would still to me be very serious.
>
> Watson, Darwin lectures, 14th March 2010

The premise underlying these projections on ecosystem impacts follow a simple decimal system. 1 degree rise equals a 10% species loss. But it would appear that there is no objective basis for this equation. It is not known how accurate a figure that is.[111] Recognition of this ignorance is not evident in quotes from broadcast documents:

> If the temperature increases by 2-3c about one third of all species face an increased risk of extinction.
>
> Arthus-Bertrand 2009: 74

> Over a third of all species will be committed to extinction at two degrees of warming.
>
> Lynas, 2006: 103

> Additional vulnerabilities at 2-3 degrees of warming (include) 20-30% of all species on earth at increasingly high risk of extinction.
>
> King and Walker, 2008: 91

> At roughly 2 - 3°C above pre-industrial, a significant fraction of species would exceed their adaptive capacity and, therefore, rates of extinction would rise.
>
> Stern Report, 2006: 289

> A temperature rise of 1-2 degrees Centigrade would see one third of the earth's species either displaced or wiped out.
>
> *Daily Mail*, April 7th 2007

[111] To underline these uncertainties, the calculations underlying these projections have since been updated, and show the species loss is projected to occur at much lower levels of warming (Smith et al., 2009).

As Watson explained, there is no way of knowing what the impact of temperature rises will be on species extinction rates. The impact could be a lot less, or a great deal more than the IPCC projections. In fact, such evidence as exists indicates the simplistic accounts appearing in the other document families are overly optimistic. The lead author of the WBGU reports, Joachim Schellenhuber, in his keynote presentation at a conference exploring the implications of four degrees of warming, discussed the burning embers diagram and then compared that with recent research to argue that, as we have already heard 'two degrees is not such a good line' anymore. He went on to say (rather sardonically), *apropos* historical acceptance of the two degree target:

> You see the two degree target looks pretty ok, yeah, it's a compromise so of course we will lose all the coral reefs if we go up to two degrees or most of them but who needs coral reefs anyway?
>
> Schellenhuber, keynote conference speech, September 2009

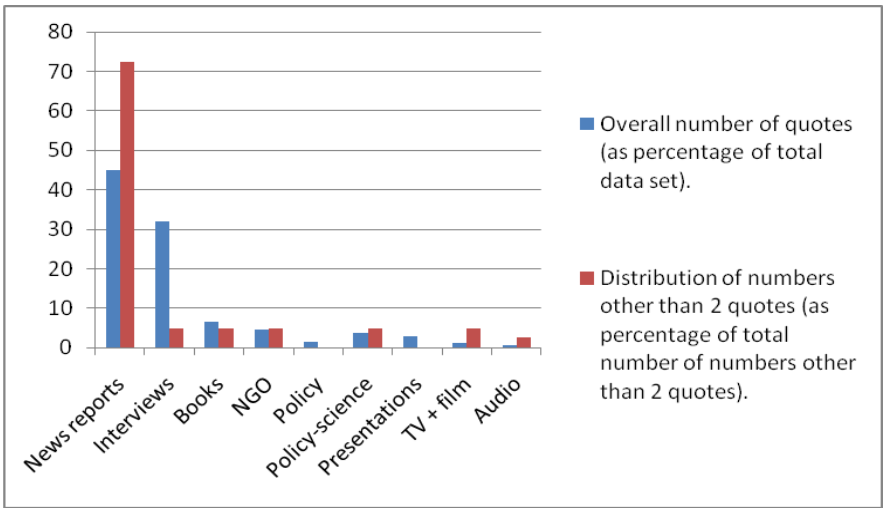
In an interview I asked one of the other key authors of the WBGU reports that if two degrees did mean the end of coral reefs, given what we know about the inter-connectedness of ecosystems, and the likely impact of coral reef loss of fish stocks, how such a loss could be considered a non-dangerous impact. The respondent argued that two degrees would not necessarily mean the loss of coral reefs and went on to discuss how projections of ecosystem impacts actually have to take account of other localised factors which make it difficult to relate impacts to a global averaged temperature rise:

> Well, with the coral reefs we know a lot about coral reefs but not enough to say when it exactly what is going to go when. Coral reefs are very complex and very different in different regions so they are under a lot of pressures, that is the basic problem here. It is not only the temperature. This is the one thing that puts pressure on them because they are already close to the limit but they can cope but there is the problem of ocean acidification coming up. Then there's the problem of massive over use, massive over consumption of species and the physical destruction of reefs and then there's the issue of sedimentation resulting from the wrong land use decisions, deforestation and soil erosion for example. They are at under at least quadruple impact and to say we are to continue like this and only look at the 2 degrees then it is very likely we will not see the type of reefs we see today in a world of 2 degrees.

7.12 Numbers other than two degrees

This category of codes encompasses those quotes which make use of numbers other than two degrees when discussing dangerous limits. In particular two degrees is to some extent legitimated in these commentaries by comparison with the expected impacts at three or more degrees of warming.[112]

Figure 21: Distribution of 'numbers other than two degrees' quotes.



As *Figure 21* clearly demonstrates, such justifications of the two degree limit are heavily weighted towards the news report document family and almost absent from the interview document family.

Some comparisons of two degree impacts to impacts at three degrees or more do not dwell on the two degree impacts, but instead reinforce the need to act swiftly to prevent any greater increases in warming:

> But time is exactly what we don't have. The key to understanding why lies in grasping the difference between a two-degree Celcius rise in global temperatures and a three-degree rise.
>
> *The Independent*, October 20th 2008

[112] I do not discuss the 1.5 degree limit, which has been examined earlier in this analysis.

> Should we fail to keep global temperature rises down to 2C, and allow them to reach 3 or 4C, we will inflict immense damage to ecosystems, farmland and weather systems.
>
> *The Observer*, December 20th 2009

> The latest research on greenhouse gas emissions suggests that while the window of opportunity of staying below 2°C is closing very fast, it is still possible. However, there are voices in the political and scientific community, especially in the UK, who are talking about a 2 to 3°C future in a rather relaxed and inconsequential manner. It is being presented that it does not matter if global average temperature rises by 2 or 3°C. This dangerous course of action is being conducted in a quiet manner so that few in the public or the media might notice the possible change in positioning
>
> WWF, Why we need to take action now, 2006

> This sounds, at first glance, hysterical, I know. What's three degrees of warming? A little extra sunscreen and a new pair of Gucci sunglasses, surely. But the overwhelming scientific evidence tells us something very different. The maximum figure of two degrees of warming on the global thermostat was not plucked randomly by Angela Merkel, the German Chancellor who tried to drag the other leaders towards it. No - it is calculated by virtually all the world's scientists to be the threshold beyond which our planet's fragile natural systems will begin to unravel rapidly.
>
> *The Independent*, June 11th 2007

> When you get hung up on numbers what happens when you don't achieve them. So if we don't make 2 degrees, lets go for 3 degrees. And I'm very nervous about 3 degrees, but I'm a hell of a lot more nervous about 4 degrees than I am of 3.
>
> Climate scientist 2

Other accounts, continuing the theme of differing between various amounts of danger, recognise that two degrees of warming is not a desirable option:

> We are running against time to stop this happening. A rise of two degrees will be tragic. Three degrees terrible. Four is unthinkable.
>
> *The Guardian*, March 12th 2009

> A rise of 3C would mean up to 170 million more people suffering severe coastal floods and 550 million more at risk of hunger, according to the Stern economic review of climate change for the UK government - as well as leaving up to 50% of species facing extinction. Even a rise of 2C would lead to a sharp decline in tropical crop yields, more flooding and droughts.
>
> *The Guardian*, December 18th 2009

> At two degrees centigrade above pre-industrial levels, there will be decreased crop yields in the developing world, widespread drought and water shortages, a near total loss of coral reefs, and the extinction of the polar bear. At three degrees, there will be increased disease, widespread species extinction, increased desertification, and a wholesale collapse of the Amazonian and Alpine ecosystems. At four degrees, melting polar icecaps would put vast tracts of land under water, and equally vast areas of the world will become incapable of agricultural production. At more than four degrees ??? Well, you get the picture.
>
> *The Independent*, October 13th 2006

7.13 Discussion

The media's filtering of the dangerous limit debate through the words of elite actors and institutions, seen in the analysis of actors and events, carries over into the descriptions of dangerous limits. Newspaper reports variously describe dangerous warming as being any warming up to two degrees, or residing at two degrees exactly, or not occurring until after two degrees, thus mirroring the confusion which was evident in policy and policy/science documents. Discussions denying the existence of any such thing as a specific level of warming which divides safe from dangerous climate change, largely absent from the policy and policy/science documents was also absent from newspaper accounts. This was also true of claims that dangerous climate change had already begun.

One of the interesting themes to emerge from the data in this section is the idea that there are different sorts of danger. Thus rather than just being dangerous, sometimes we are confronted

with “catastrophe” or a distinction is drawn between “dangerous” and “very dangerous”, or “reversible” and “irreversible” dangers. These ideas of different forms or degree of danger can arise in discussion of geographical variation in impacts wherein what is dangerous for some may be merely inconvenient or even a benefit for others. However, non-differentiated accounts of danger predominate.

So, in general terms, the words “two degrees” are associated with “dangerous climate change” through various and inconsistent means. Elite theory as understood in my research would identify the media, industry and policy making bodies as, at an institutional level, bound by elite norms. Consequently, though the mainstream media may not be wholly populated by individuals who would be recognised as elite actors, it is an elite institution in so far as it is identified in this research as an echo chamber for the opinions of elite actors. The similarities in the two degree discourses across the different news titles may be the result of structural constraints, rather than any conscious plotting. The need to communicate complex information in a short article is an example of how such structural constraints are felt. Journalists are working within tight word count limits, and with a readership which only reads the first part of a news report.[113] Therefore quoting experts acts as shortcut which allows information about the subject to be communicated quickly and with authority. Such an approach also, in the case of the two degree limit, ignores the uncertainty and values which define the defining of a dangerous limit.

The uncertainties which are prevalent in projections such as those which claim at two degrees 20-30% of species will be made extinct (a figure whose accuracy one of its architects admitted was impossible to know) were not of great concern to the NGO communities. Whilst the inadequacies of assuming a two degree dangerous limit were sometimes recognised, the target was still advocated for as being the best deal available. In other instances very clear arguments for two degrees as a definitive limit were made. In not consistently and robustly proposing critiques of the two degree target many environmental communications act to reinforce the simplistic interpretations provided by the media. One exception to this was reference to calls for a 1.5 degree limit from some nations from the global South. Again, notions of a linear relationship between emissions and warming, and clearly definable danger limits, formed the dominant framework for these discussions. However, in interviews with campaigners, a very different picture emerges, in which ideas of a dangerous limit are treated with suspicion and caution. In some instances there was an attempt to disassociate the organisation with any claim to a two degree dangerous limit.

[113] See ‘Eyetracking the News: A study of print and online reading’. (The Poynter Institute, 2010).

Books and TV/Film in having the space to explore these issues in more depth, did not often take the opportunity to explore the ambiguities of the evidence for a two degree dangerous limit. Again, as with the NGO data, where such questions were raised, they were quickly skated over as the calls for a two degree limit were made. This was even true of the book titled *Two degrees too high*.

In contrast to the above accounts science interviewees (bar one) were very clear on the fallacy of arguing for a two degree dangerous limit, or indeed any kind of a limit all. The next section will analyse the extent to which other commentaries recognise the absence of science from the setting of a two degree limit. Instead, climate scientists regard the defining of dangerous limits as a political exercise. The politician interviewed in this part of the analysis saw the threshold concept as having a genesis in the climate science community, even if it had since become politicised.

Forty five percent of all my quotes come from the newspaper document family. Additional sources include radio news programmes and documentaries. Even totalled up, these figures probably under-represent the true extent to which the broader public audience relies on these broadcast commentaries for information about climate change. Discussion of a two degree dangerous limit did not really figure in media commentaries until the Copenhagen meeting in December 2009. The reporting of the two degree limit both pre - Copenhagen and now, has been confused, confusing, and sometimes contradictory. The same can largely be said of NGO communications. Yet it is the two degree number that dominates whenever dangerous climate change is discussed, even though sometimes that reference maybe (in the case of some NGO documents) mildly critical. Even after raising such uncertainties, the belief in a dangerous limit, normally off two degrees, is reasserted.

Chapter 8

Coping with uncertainty

8.1 Introduction

The first chapter of this data analysis examined which actors, institutions and events were invoked when discussing the two degree limit. Media reports showed a distinct orientation to discussing the two degree limit through the words of authoritative political, scientific and institutional actors. These accounts tended to elide discussion of the uncertainties surrounding the two degree limit and the normative nature of the two degree limit.

The second chapter of this analysis compared differences in how the impacts of climate change are mapped on to different levels of warming. There were notable variations in descriptions of dangerous impacts and the warming levels which create danger. Dangerous climate change was seen to occur, variously, between one and three degrees of warming. Some commentaries sought to demarcate dangerous climate change from catastrophic climate change that would occur over two degrees of warming. Claims of a clearly definable dangerous limit were questioned by actors interviewed for my thesis, and in presentations from other climate scientists and researchers.

The third and final section of this analysis examines the justifications given for fixing on the two degree limit. Is it described as a scientific fact, a political necessity, an idea which derives its value from being easy to communicate and understand, or an economically feasible target? Is it a mixture of all these things, or the product of something else entirely? As in the previous sections, while the primary aim is to describe how these justifications are employed, I also compare their use across the different discourse communities.

Table 15 (below) lists the code categories used for this section of the analysis, and the number of quotes identified in each category.[114] Each of these code categories is made up of smaller individual codes. I work through the code categories in order of size, as measured by the number of quotes linked to the codes.

[114] Ordering the quotes into separate codes, and amalgamating these individual codes into larger code categories, assists in management and accessing the data. However, when closely analysing these quotes qualitatively the distinctions between some of the codes is rather indistinct. Where breaking down the qualitative analysis by code seems artificial or overly forced, I instead work through the quotes in a narrative style which bridges the connections between the different codes rather than treating them as separate entities.

Table 15: 'Dealing with uncertainty' code categories.

Code categories	*Number of quotations*
Anchoring device	112
Science	95
Uncertainty	87
Values	87
Role of politics	87
Economics	35
Distancing devices	27

8.2 Anchoring device

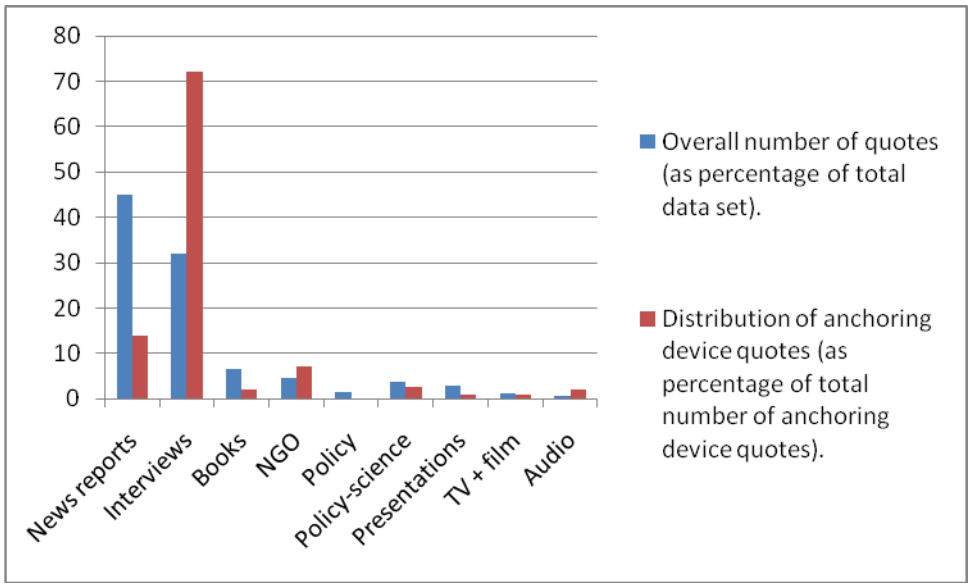
The "Anchoring device" code category is used for quotes which, either implicitly or explicitly[115], identify the importance of the two degree limit in terms of its role as a stable discursive object which can be understood by all epistemic communities involved in the debate. I also use the term in the sense defined in social psychology wherein anchoring is a process which makes unfamiliar risks familiar by imbuing them with recognizable attributes.

Figure 23 (below) shows that the quotes attributed to the "Anchoring device" code category are weighted towards interviews and are under-represented in newspaper accounts and books. This finding establishes the pattern that has run throughout this analysis, namely that there is a discrepancy in representations of the two degree limit between broadcast documents such as news reports and NGO commentaries, as opposed to interviews, presentations and other accounts of the concept given to knowledgeable audiences. The majority of broadcast commentaries treat the idea of a dangerous limit in simplistic terms, avoid examination of the normative elements of the two degree limit, and turn to elite voices to reinforce the concept of a two degree dangerous limit to climate change.

In Chapter 7 I showed that anticipated significant impacts at or below two degrees on human and non-human life were not interpreted in the data as reason for rejecting the idea of two degrees as a dangerous limit. So, given the negative consequences projected to arise from allowing continued warming of the global average temperature, how is the two degree limit justified?

[115] The "Anchoring device" code itself is for those quotes which explicitly describe the two degree idea as an anchoring device. Elsewhere the meaning is implicit; I as the researcher am interpreting what is said to mean the limit is being described in a way which allows it to function as an anchoring device.

Figure 22: Distribution of quotes for the 'anchoring device' code category.



Interview data revealed a widespread recognition of the importance of agreeing a fixed quantitative value for dangerous climate change which could function as an anchor for discussion, a fixed object around which a policy architecture can be built. According to this perspective, without a fixed figure, good or bad, the whole policy edifice collapses. One respondent, working at the UK Met Office, saw the policy imperative as the basis of all agreements so far reached on limiting carbon emissions, and to criticise it would be to bring the whole pack of cards tumbling down:

> This 2 degrees figure is so much edged into sort of discussion on mitigation if you're starting to sort of undermine that when there's such crucial negotiations coming up then you basically make that figure look weaker or in the worst case you know give politicians reason to disregard it without anything to replace it.
>
> Climate scientist 3

This idea of needing to fix a number to meet the demands of policy was commonplace across the discourse communities:

> The EU has defined a temperature threshold - limiting the global average temperature change to less than 2^0C above pre-industrial. This goal allows

> policy-makers and the public to debate the level of tolerable impacts in relation to one simple index.[116]
>
> Stern Report 2006: 28

> We can start to hang things on it, use it as a peg you know? Right, we don't know how much we can reduce, how fast we can reduce, how things are going to play out but this can give us something to aim for.
>
> Campaigner 5

> What it does do is provide a concrete commitment similar to the 60% commitment in the UK that you can latch onto.
>
> Science/policy academic 1

The simplicity of the two degree idea was believed to serve a useful communicative function, not only between climate policy actors but more importantly, for the broader public. This opinion was especially apparent amongst campaigners, but was also shared by actors working at the science/policy interface. From this perspective the number has to be a simple figure, a stable figure, and one communicated with certainty:

> We are asking people to do big things to change their lifestyles, to change the way they use energy and we need to make a cogent argument to people why were trying to do it and the reason were trying to do it is much clearer now than there was before we got agreement on 2 degrees.
>
> Campaigner 11

> It's similar to a speed limit on the road. Of course in the end the public has to decide; do we put it at 50 or at 60 because a limit at 52.6 wouldn't be communicable. But with the 2 degree limit the communication is more important than others because it's not something that gets measured by specialists and communicated to other specialists and the consumer doesn't know, but this is something that has to be communicated to the public.
>
> Science/policy academic 6

[116] I have not been able to identify any political debate on the topic at the national level, where public opinion could be expressed through the ballot box. All three main parties in the UK (and The Green Party) are in agreement on the two degree target (for the latter party's stance see, for example, the Green Party's 'Policy pointers' leaflet from March 2010 (http://policy.greenparty.org.uk/policypointers/ppclimatechange.pdf).

> Uncertainty is really not a big help in the political domain and public communication. If there is some kind of certainty that going past 2 degrees would be dangerous, catastrophic, then the politicians who are resistant to change and the public in general who are resistant to change in general I think will hang on to that.
>
> Campaigner 1

> We had a negotiators workshop last December run by one of the UN negotiators and they were basically saying that this 2 degree limit above pre-industrial times is more communicable than other rises, sets a kind of mental path for people to imagine. 2 degrees is this, we know what a 2 degree rise is in our minds.
>
> Campaigner 2

Fixing the two degree limit in order to provide a stable entity for policy and communication purposes is identified in some quarters as being in conflict with an evolving body of knowledge about climate change:

> I think there are real difficulties in the sense that the science is moving so fast and the politics is struggling to keep up and we've now kind of fossilised this 2 degrees as some kind of totemic value. I think there's almost a culture of deliberate deception, that sounds very strong but I think that's what it is. It is deliberate deception and I think it's very easy to fall into that trap of just accepting that two degree figure, recognising that anything else is too complicated, too difficult to communicate or at least get acceptance for. So there's a kind of shared complicity in this adoption of the target which as the most recent science shows is absolutely not going to be safe at all.
>
> Green Party MEP

> The science on global warming is moving very rapidly now, and so while it's important for EU policymakers to recognize the IPCC's work and recommendations, they should also be aware of new information.
>
> Campaigner 7

> Before long, however, the spitting began in earnest, as the revolt of the potential victims got under way. It was targeted at the two degree limit, since new science is increasingly showing that this would not be enough to prevent low-lying countries from being inundated or catastrophic harvest failures and other disasters striking many of the poorest and most vulnerable nations.
>
> *The Daily Telegraph*, December 12th 2009

The conflict between the policy and communication need for a stable figure and the ever changing scientific evidence base is revealed in discussion about the receding possibility of avoiding more than two degrees of warming, such discussions occurring even before the Copenhagen Accord was finalised, which declared the need to stay *below* two degrees of warming:

> A rise of two degrees centigrade in global temperatures - the point considered to be the threshold for catastrophic climate change which will expose millions to drought, hunger and flooding - is now "very unlikely" to be avoided, the world's leading climate scientists said yesterday.
>
> *The Independent*, September 19th 2007

The majority of presentations on the topic are doubtful, rather than certain, about avoiding more than two degrees of warming:

> I would argue it's an incredible stretched target, I would argue it's very, very difficult to meet, although many politicians still believe it's plausible. It's plausible but not likely in my opinion. Therefore I would argue we need to get ready to adapt to 4 degrees Celcius.
>
> Watson, Darwin lecture, 14th March 2010

Questioned about the relationship between government emissions targets and levels of warming, and the possibility of avoiding more than two degrees of warming, the Chair of the Committee for Climate Change reminded the panel that definitive statements about avoiding particular levels of warming are a fallacy:

> If you said, "We must definitely not go above 2°C", I think that is close to impossible to achieve these days. As I say, you have to remember that you cannot say, "The aim is not to go above 2°". That is just not a doable aim. You have to define the aim as, "I don't want a more than `x' per cent chance of going above 2°". Once you have accepted that there is already a certain chance of going above 2°, you are trying to work out how big a chance you are willing to accept. We ended up believing that the most vital thing is to keep the chances very, very low that we go to really high levels like 4°. We would also be very worried obviously if we went above 3°. That was the approach we used, therefore. We did not consider ourselves bound by the 2°. I think that it is now in a situation where it is very difficult for the world to get the chances of going above 2° to very low levels. If you said, "We want to have a strategy which gets the chances of going above 2° below 10 per cent", I think that we would need far tighter targets than anybody is suggesting. Basically, we believe that policy at any time should be guided by the idea that, on the basis of the best scientific evidence existing, the chances of, at some future date, going above a catastrophic level is kept at a very low level, where we somewhat arbitrarily define "catastrophic" as 4° and somewhat arbitrarily define "very low" as one per cent.
>
> Lord Turner, Environmental Audit Committee transcript, 4th February 2009

However, away from such intense interrogation, the other key players in the science/policy interface ignored such probabilistic assessments when considering opportunities for avoiding more than two degrees of warming:

> Two degrees above pre-industrial, of course that's one of the backgrounds, that's the EU target, should be two degrees or so. That's almost inevitable - we are going to have to do a lot now if we are to get anywhere near that and that's clearly one of the backgrounds to what we are doing.
>
> Hoskins, Dangerous Rates of Change conference, September 20th 2008

> I will talk actually about 2 things, the 2 degree line if you like, the rationale for it but also what if we cannot hold that line and it's true that there is increasing evidence that it will be extremely difficult to do so.

Schellenhuber, 4 degrees conference, September 14th 2009

> We had a similar situation in the World Bank about a year ago. The World Bank produces a report called the World Development Report. It's the premier publication of the bank, it has the imprint of the President and what have you and we had to make a decision with climate change. Do we discuss a world heading for two degrees or do we discuss a world heading for something way above that. Now we finally decided, balancing various political pressures and what might have the most impact on the various readers, we're talking about the two degree world. We took a lot of advice even from Schellehuber and basically we came to the view that two degrees is possible, is feasible but it's such a stretch that if you don't wake up guys and get moving it will be gone. In fact I think it has gone.

Noble, 4 degrees conference panel discussion, September 15th 2009

> We haven't got a cat in hell's chance of using mitigation to hold the 2 degrees c because we basically don't care. So 4 degrees c if we're lucky.

Anderson, presentation given at 4 degrees conference, 15th September 2009

In two instances, acceptance of warming in excess of two degrees was ameliorated by a belief that two degrees is not much of a target anyway:

> Though it's now almost impossible for us to stay below 2c, it's not a dramatic threshold above which something bad would suddenly happen.

King and Walker, 2008: 99

> This 2 degrees is arbitrary, it could be 1.5 degrees, it could be 3 degrees, a limit has to be made and has to be considered so effectively policy can be tailored to that to a certain extent. Most people just throw their hands up in the air and say 2 degrees is just totally unachievable let's go for 3 degrees.

Science/policy academic 3

What these quotes have so far revealed is an arbitrary decision making process which is primarily designed to meet the needs of policy and an idealistic notion of a simple idea which

is easily understood by the public. No claims are made for a strong scientific basis for the two degree limit.

How, then, is consensus built and maintained in the absence of strong scientific evidence? This is not easy to discern:

> So there is this problem of translation so it is very difficult to represent the thinking that underlies setting targets limits or whatever and that's a really tricky problem to overcome.
>
> Science/policy academic 3

> It's not a science issue, it's a science and policy issue a culture issue and a society issue all rolled up into one big mess.
>
> Climate scientist 1

News reports, rather than reflect this confusion, perform a volte face and describe the two degree limit as a scientific consensus:

> Now a new scientific consensus is emerging - that the warming must be kept below an average increase of two degrees centigrade if catastrophe is to be avoided.
>
> *Independent on Sunday*, February 6th 2005

> So what do we need to do to stay this side of 2C? There is a very broad, rock-solid scientific consensus that we need a cut of 40 per cent in the most polluting countries' emissions by 2020 if we are going to have even a 50-50 chance of doing so.
>
> *The Independent*, December 21st 2009

> There is scientific consensus that Kyoto's successor should cut carbon emissions to the point that average temperatures do not rise by more than two degrees Celsius.
>
> *The Observer*, September 20th 2009

Even where uncertainty is recognised, the idea of a consensus is used as justification for the two degree target:

> But what "dangerous" means has not been defined, though there is a consensus growing around two figures.
>
> *BBC News online*, 26th November 2005

> A better question is how much climate change can we afford before things become truly catastrophic? Though the answer is full of scientific uncertainties a broad consensus is beginning to emerge.
>
> King and Walker, 2008: 90

> Any level of climate change is dangerous for someone, but there is a broad consensus about what this word means: two degrees of warming above pre-industrial levels.
>
> *The Guardian*, 1st May 2007

The idea of a growing consensus built around a solid scientific base was frequently challenged by respondents who work in areas of climate science, climate policy and economics:

> I think this is very much something that is sociologically and psychologically constructed and it's just sort of emerged as a focal point if you will.
>
> Climate scientist 4

> My core thesis is that this is just group think - someone shouted 2 degrees, and as no one has a clue really, everyone shouts 2 degrees.
>
> Economist 1

> I don't think it's got any scientific legitimacy. I don't think it ever had any scientific legitimacy.
>
> Climate scientist 1

> How do I put this? I think the concept is not incredibly useful. There is so much uncertainty the results are almost meaningless.
>
> Science/policy actor 4

We see in these accounts that the two degree idea is treated as an unexamined given; it has been in effect black-boxed even for many of the actors working in the field of climate change policy. Such is the obscurity of the rationale for the target it is referred to as a 'magic' number by one campaigner, and a 'talisman' in one newspaper story. When I asked an ex- adviser to the Environment Department of the UK's Labour government where he thought the two degree number came from he said he didn't know. Indeed, the origin of the idea was, both to him and his colleagues, so mysterious, and belief in it required such an act of faith, that people in the department referred to it as the 'theological two degrees'.

The attempts to fix the debate around a two degree limit are a symptom of a deeper commitment, namely a commitment to the belief that any meaningful response to climate change must be articulated through the language of targets. The construction of climate change as a phenomenon manageable through targets was apparent across all document families:

> The lack of any legally binding targets led environmental campaigners to condemn the summit as a failure.
>
> *Mail on Sunday*, December 20th 2009

> Greenpeace UK director John Sauven said "An agreement without targets is barely worth the paper it's written on".
>
> *Daily Express*, June 8th 2007

> "I think there is reason to be optimistic - it's the first time we've ever got the world to think about a single-number aspiration: that we should not cross more than two degrees of global warming," said Chris Huntingford, of the Centre for Ecology and Hydrology.
>
> *The Observer*, December 20th 2009

> Ok John, if the targets are, as Richard says, important, which clearly they are, then how do the measures measure up to them? You know, last week the G8, which last time I checked we are still part of, was talking about ensuring temperature rises are kept below 2 degrees Celsius. Looking at what's on the paper here, is that going to achieve that for us?
>
> *BBC Material World* podcast, 16th July 2009

> What figure should we aim for? This is the first and most important question to answer. Until we have a specific target we will have no idea what technological or political solutions will enable us to achieve it.
>
> King and Walker, 2008: 89

> There's a feeling that whatever target you pick is somewhat arbitrary because you don't actually necessarily know that at 1.9 degrees it won't be that bad and suddenly at 2 degrees you have catastrophe. But, at the same time, from an NGO perspective we really felt like it was important to have everyone working toward a common goal which is something that political leaders also expressed, that there needed to be some kind of shared vision. From our perspective it's really, really hard to measure how countries are doing unless you have some kind of benchmark.
>
> Campaigner 11

> The rest of it is crap but without targets you are nowhere. That's a fundamental principle you have to establish.
>
> Campaigner 6

Targets are about more than meeting the demands of policy. Climate targets are, I suggest, both the means and ends of modernity. The ends in as much as the setting of targets serves to postpone action which challenges the limitless possibilities promised by modernity. The means because the idea of managing climate change through a targets framework arose alongside a developing concern about human influences on the climate. The initial concerns about the potential climate impacts of changes to the chemical composition of the atmosphere arose within western meteorological institutions from the middle of the twentieth century[117]. Such institutions, with close ties to the military, were both the product and servants of the project of modernity. Government and private funds were made available to these departments to investigate further the possible impacts of human industrial activity on the climate.[118] However there were significant constraints on what could be achieved. As one researcher I interviewed explained it:

[117] See Fleming (1998: 119).
[118] Ibid (121-122). See also Weart (2003: pp 55-65) for discussion of mid–twentieth century attempts at climate modelling.

> You see, the thing about short term numerical weather forecasting models is you can basically reiterate the model. You know, you can take a load of climate data and say "this is a representative data set which we are interested in" and then you can run a model, create a dynamic model of it which reflects factors and relationships established in the model. We then run the model forward with that input data for today and then we wait 10 days and see whether it turned out right and where the variations were on the prediction. Because you've got the time to correct the data again and then check the model and then you can re-establish the model again in the light of corrections, dislocations between your predictions and the actuality, the standard kind of scientific stuff. Point was, when you go to long term climate predictions you can no longer do that, you can't say "oh well, let's wait 75 years to see if our prediction was correct". So they then had to find new ways of validating.
>
> Science/policy academic 2

This inability to validate long term forecasts against real world observations meant it became necessary to rely increasingly on statistical models to forecast long term changes, within the narrowest possible probability margins. This modelling was dependent on parameters which would produce statistically significant results. Modelling on a 5% increase in CO_2 would not produce results which were free of statistical noise. In 1970 the Rand Corporation, in response to security concerns about climate change, worked with scientists to construct predictive models based on a doubling of CO_2.[119] As noted already, this doubling has since become the *sine qua non* of climate policy and targets. The point I wish to make, *apropos* targets, climate change and the ideas of anchoring devices, is that recognition that human activity may impact the climate arose within a quantitative framework at a time of "high modernity" between the immediate post-war period and the 1970s.[120] Scientific progress, faith in the ability of science to deliver progress and provide control over the world is a defining feature of high modernity. This new risk of climate change was almost inevitably going to be framed within the quantitative epistemology and ontology which so defined the period of high modernity. The assumption that human impacts on the climate could be understood and controlled through a quantification of the relationships between the relevant factors, combined with limits on computer models forced the turn to statistical modelling, enabled by increasing computer power. The demands of statistical modelling required the input of parameters which would

[119] Fleming (1998 : 131).
[120] See Giddens (1990) for one discussion amongst many of what might be meant by 'high modernity'.

produce statistically reliable results. Hence the inbuilt assumptions that developed in this modelling from around 1970 that the world would face a doubling of CO_2 concentrations, which models predicted would lead to approximately two degrees of warming.

Though my analysis of the data in this section has revealed widespread ignorance about the origins of the two degree limit I did identify two quotes which trace the two degree target to these statistical requirements:

> Doubling looked like it was a plausible likelihood. It was going to happen anyway, given the trend of increasing that was going on. It wasn't going to be that long, that unimaginably far in to the future. It counts as an interesting extension of existing modelling, so in that sense it was plausible it's going to happen sometime, whether its 50 years or 100 years doesn't really matter. And so it's a simple kind of increase factor, as it were, to, you know, to talk about and to think about and to try to analyse when it comes to constructing and testing models and so on. It needed to be an increase that was revealing differences. Differences of 0.2 degrees of temp increases would have been within the existing amount of statistical variation of existing models. It had to be something that would produce a temperature increase in the models that was observable.
>
> Science/policy academic 2

> We had a negotiators workshop last December run by one of the UN negotiators and a seminar and a seminar from Sweden's Larrs representative in the negotiating team in the last 5 years. They were basically saying that this 2 degree limit above pre-industrial times, this is a target that first of all seems good as a target, because that is meant to have certain effects. You can perhaps measure a two degree rise more than other.
>
> Campaigner 2

8.3 Science

Building on from the previous section, this part of the analysis examines in more detail how science features in descriptions of the dangerous limit.

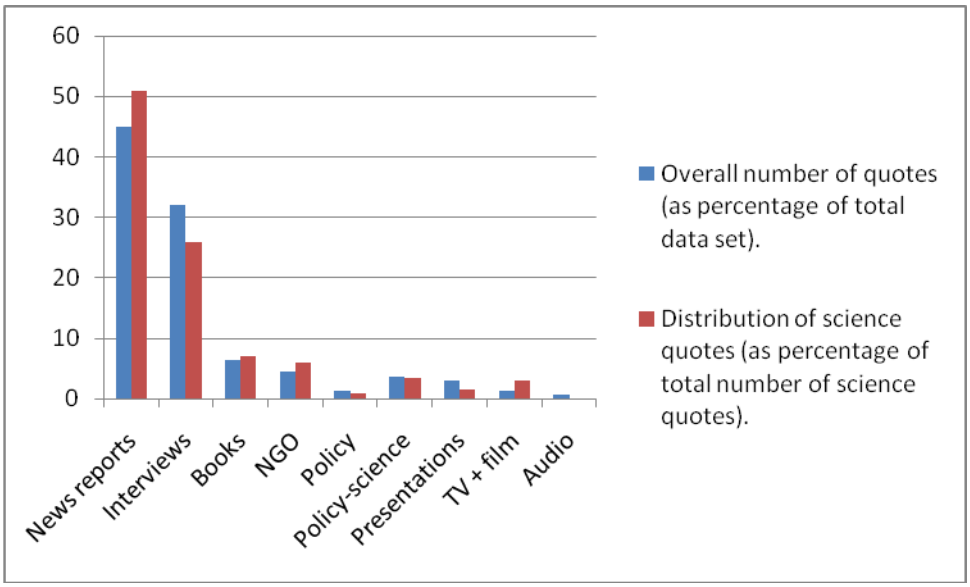
Table 16: Science codes.

Code	*Number of quotes*
Scientific expertise	52
Scientists say it's dangerous	33
Not the job of science to define dangerous	10

Figure 23 (below) shows that when the three "Science" codes are aggregated, one can see discussion of science in relation to two degrees is in line with the average number of quotes provided by all document families. In other words, all of these data sources make reference to science to, proportionally, the same extent. However, if one analyses the codes separately an interesting pattern emerges. 24% of the "Science says it is dangerous" codes come from NGO documents and 63% from newspapers. Together these two document families account for 87% of these quotes. There may be more than one reason why these quotes are clustered in these two document families. This pattern possibly reflects a conscious desire to avoid discussion of uncertainty[121]. Or it may be a structural constraint borne of the need to communicate a complex idea in a limited amount of time and space. By this I mean the intended readership for these texts may not have the desire or time to engage with lengthy discussions of risk. This is as true for campaigners as journalists. Campaigners face problems of limited media space and short reader attention spans. These constraints make it difficult to get media exposure for lengthy and complicated treatments of climate change issues.

[121] Roger Harrabin, the BBC's chief environment correspondent, in an email exchange with me, identified an aversion to uncertainty both within political circles and the media. This he identified as a vicious cycle – reporters will attack any sign of uncertainty in policy-makers, whilst the media itself has little time for nuance. In defence of this position Harrabin wrote – 'You try writing an uncertainty headline' (Personal communication 9th March 2010).
Further insights into the policy-media dynamic on uncertainty can be gained from the transcript of a BBC Radio 4 documentary examining how uncertainty is avoided in public discourse. A former Education Minister for the Labour government described on the programme how politicians would change their language when speaking on and off the record: 'Put the media in between us, a journalist say to me, "Could you speak to the public through me, the journalist?" and you change completely. You adopt the language of certainty. And that's partly because of a very simple thing: you're on the record, it can be thrown back at you'.
The presenter of the programme then had the following exchange with a journalist member of the panel.
Presenter: 'Would we really rip into any minister who confessed to uncertainty?'
Journalist: 'In the first instance, we certainly would, we certainly would'.
Presenter: 'Why would we because it's not an unreasonable position, is it?'
Journalist: 'We regard it as an unreasonable position. We feel as journalists we want to achieve one of two things: a very clear answer which breaks new ground; or we want to look as if we're the one with big testicles, right?' (BBC Radio 4 Analysis: Dead Cert. Broadcast 6th November 2008).
Smith, in his observations of meetings where the BBC discuss their reporting of risk issues, noted 'Journalists have demanded to know what facts there are—or to demand "when are we going to get to the truth on climate change" and do not carry with them a sense that science is primarily a process of contestation (2005: 1474).
See also Weingart, Engels and Pesengrau for a discussion of journalistic aversion to uncertainty (2000: 274).

Figure 23: *Distribution of 'Science' codes across the document families.*



8. 3. 1 Scientific expertise

On two occasions, actors working in the field of climate science argued that whatever the gap between science and target setting, it can be resolved through more and better science:

> My response is to redouble the effort on the science, so that we can provide better information about the effects of the different targets, and so we have a more solid base to kind of push society to sort out the values issues on the basis of solid information.
>
> Climate scientist 4

> There are uncertainties about our ability to manage the issue but we can compute and quantify the probability about avoiding certain kinds of impact. We can model these or in some other way estimate when they are likely to occur and with what probabilities.
>
> Policy/science actor 5

One researcher, working in science previously but now in a more theoretical role, was more sanguine about the assumption that climate science can answer all the remaining questions:

> A month ago there was a big summit on climate prediction and again all the climate scientists were saying you know "we need $1 billion to increase

> computational power" and now the new holy grail is that we can adapt to climate change because we will provide the information we need. So I do think that creates expectations, raises the stakes. For example, when we plan or have to make decisions about various things we don't try to predict where exactly is globalisation going, what exactly is the world going to look like in 2050, but somehow, because somehow climate science goes through a model or it goes through the laws of physics, it raises the bar in such a level, that it is evidence that is above other things, and we are aware it should not be because it is so uncertain.
>
> Policy/science actor 4

Media reports constructed science as the final authority on dangerous climate change:

> Scientists tell us that the next eight to 10 years will be critical in terms of whether we have any chance of avoiding the worst of climate change.
>
> *The Independent*, August 21st 2007

> The world's leading scientists - 2,500 eminent men and women from 130 countries - yesterday issued an unequivocal warning that the Earth is getting hotter ... and it is our fault.
>
> *Daily Mirror*, February 3rd 2007

It seems reasonable to argue that the effect of these stories, combined with the quantitative paradigm which provides the dominant frame for climate change, is to reinforce the idea that climate change is a scientific problem. This then provides a context in which descriptions of the dangerous limit as scientific can seem more credible.

The book data analysed also provided a significant number of quotes which used science to arbitrate on questions of climate change:

> The texts and charts that have been included are based on the work of the Intergovernmental Panel on Climate Change, which consists of the top scientists doing research on the subject. Thanks to the findings of these scientists, we know that the global temperature will increase by a minimum $2^{o}C$ over the next several decades.
>
> Arthus-Bertrand, 2010: 12

> Even before the advanced model predictions in the IPCC report were available, researchers had been trying to put a figure on how much warming humans can bear. Perhaps surprisingly, and through quite different reasoning, many of them have hit on exactly the same figure of 2 degrees centigrade.
>
> King and Walker, 2008: 93

8.3.2 Science says it is dangerous

It is only a short step from the above associations between science and climate change impacts to explicit descriptions of the dangerous limit as scientifically derived. Such claims are predominantly found in news reports, which provided 59% of all such quotes. Whilst these are not always explicit statements along the lines of "scientists say two degrees is dangerous", the close association of science with descriptions of the two degree dangerous limit achieve the same effect:

> His prediction ahead of the critical Copenhagen summit in December will alarm those governments and scientists who warn that a rise of more than 2C risks disastrous consequences in terms of food security, migration, sea-level rises and extreme weather events.
>
> *The Guardian*, September 17th 2009

> "There is no doubt that we should aim to limit changes in the global mean surface temperature to 2C above pre-industrial," Professor Watson, the chief scientific adviser to the Department for the Environment, Food and Rural Affairs, told the Guardian.[122]
>
> *The Guardian,* August 7th 2008

‘

> The science is now clear that if we do not manage to keep the increase in the earth's temperature below 2C, we risk facing the effects of catastrophic climate change.
>
> *The Guardian*, September 16th 2009

[122] This is the same Professor Watson who elsewhere in this analysis has been quoted as questioning the two degree limit and admitting there was no way of accurately predicting the impact of warming on rates of species extinction.

> A rise of two degrees centigrade in global temperatures - the point considered to be the threshold for catastrophic climate change which will expose millions to drought, hunger and flooding - is now "very unlikely" to be avoided, the world's leading climate scientists said yesterday.
>
> *The Independent*, September 19th 2007

> Will world leaders reach an agreement that will stop the atmosphere warming more than two degrees above pre-industrial levels - the level scientists say will avoid the most disastrous consequences of climate change?
>
> *The Observer*, September 20th 2009

The association made in the press between science and the two degree dangerous limit is even more explicit in NGO communications, whether in the form of pamphlets, on their websites, or in books[123]:

> It is imperative that humanity takes action to rein in global warming and to stop global temperatures rising by 2°C. This is the target determined on the basis of the science, and by observation of what is happening in the world.
>
> Tearfund, May 2007

> Many scientists say we need to limit temperature increases to a maximum of 2 degrees C to avoid “dangerous interference with the climate system”
>
> Only Planet, 2007: 32

> Scientists warn that action must be taken, before the year 2050, to prevent climate change reaching dangerous levels, by limiting global temperature increase to well below 2° Celsius.
>
> 2^0C – Too High!, WWF 2006

> The Nobel prize winning Intergovernmental Panel on Climate Change (IPCC) has warned that global emissions need to peak by 2015 and decline thereafter

[123] Sources identified in my data included this passage from the ‘Stop Climate Chaos’ website ‘Climate change science tells us that we must keep global warming below 2 degrees C. If not, we’ll dive headlong into climate chaos, which will be dangerous and irreversible’. However, this passage has since disappeared from their website.

> if we hope to keep global average temperature increase to within 2 degrees Celsius, which scientists say is the tipping point to avoid catastrophic damage from climate change.
>
> Seal The Deal booklet, 2009: 4

> Science tells us that to prevent some of the worst impacts we need to keep average global temperature rise well below 2 °C and reduce warming as fast as possible.
>
> Greenpeace website, Change the Future campaign, 2010

> 'As the temperature rises, more and more serious phenomena appear in the scenarios. The most dramatic occur after the average temperature has increased more than 2c from 20th century levels. This is why scientists have set 2c as the limit that should not be exceeded'
>
> Arthus-Bertrand, 2009: 8.

The UK Department of Energy and Climate Change (DECC) even goes so far as to include the two degree limit as scientific reality in its list of ten facts about climate change:

> The scientific consensus says we need to stop the world getting more than 2 degrees warmer than pre-industrial times if we want to avoid dangerous climate change.
>
> Department for Energy and Climate Change, 2010.

When I asked respondents "Whose job should it be to define dangerous?" only two respondents, one an environmental campaigner the other a German[124] climate scientist, were willing to make the case for the dangerous limit as a scientific description:

> It should be the job of scientists. Without government interference, without political feasibility, without advocacy groups or lobbyists.
>
> Campaigner 7[125]

[124] I mention the respondent's nationality here because Germany has been the main driver behind EU calls for a two degree limit. Germany is the most powerful nation in the EU and it is Germany that commissioned the WBGU reports into the setting of a two degree limit. I therefore sense a certain (defensive) proprietary perspective on the scientific rationale for the two degree limit.

> You need scientific statements, so you need a change within science so they are willing to give statements about the range of dangerousness beyond that they diagnose surely. So we are in this process and some scientists who are aware of this inner scientific change and the label is sustainability science and many are pushing for this transformation of science itself.
>
> Climate scientist 4

8.3.3 Not the job of science to define dangerous

Explicit rejection of the idea that the dangerous limit should be defined by science was restricted almost wholly to interview data. The importance of science to the climate change debate is not challenged, rather it is a case of clearly marking the point at which the science stops and values begin:

> Of course it's not the task of the scientist to push, it's the task of the politicians to decide upon this level in a democratic process where those levels or guardrails are going to be set.
>
> Policy/science actor 6

---

[125] This quote comes from a representative of the campaign group 350.org which, as the name suggests, promote a targets based approach to climate change. Another campaigner I interviewed, who works on climate change issues mainly in the global South, and who generally rejected discussion of a quantified dangerous limit as an essentially neo-liberal discourse, had met representatives of the 350.org group at a conference. He revealed that his conversation with the 350.org representatives revealed a wide divide on the issue of dangerous limits. The respondent working in the South told me,

> They sort of were friendly and laid out their thing and said "you know, we have had all these nationwide demonstrations and our starting point was 2 degrees, our starting point is we have to cut emissions, we have to have targets. Emissions have to be stopped at this level, this is our first step. Once we can get a movement aligned around" (2 degrees, or a movement aligned behind whatever target it was they were talking about their idea was), "this is the major thing we need to do, the first step we need to take and after that we can work out how we are going to do it". And I said "frankly in all of these discussions over many years (with indigenous people from the South) the issue of emissions targets and the issue of 2 degrees and the issue of 350 parts per million has never once come up. In reality when you are talking climate politics with people in the South, this is not where the core of the issue is, I mean, it is really not the core of the issue and it has never come up in our real practical work with our groups in the South". And the two students, they sort of at first they thought we were either kidding or we weren't really feeling the climate problem or we weren't of use to them and their movement. Their communication, in a way their sympathy for us, just melted away and they didn't understand what we were trying to waste our time about if we weren't trying to organise the world around 2 degrees or 350 parts per million or whatever it was.

> I think to a certain degree it is tied up with, I mean I wouldn't want to blame scientists, but some climate scientists, especially those who felt the pressure of policy makers and business interests have been complicit in formulating the 2 degree idea, the idea that there is some safe limit, or probabilities can be calculated or so forth. A lot of scientists have been complicit in that and part of that is due I would think due to pressure from policy makers, or felt that the idea that there will be pressure from policy makers and business. But part of it may be due to ingrained linear thinking among a lot of scientists who frankly should know better.
>
> Campaigner 12

> We are telling people what might happen at different levels but we can't say more than that so the identification of a particular target has to come when scientists step outside of their role as providers of information.
>
> Climate scientist 4

> For me it's a role for the scientists to present our best understanding of what's going to happen. What are the consequences of different actions or different thresholds being crossed or whatever and then saying it's not the job of scientists to place a judgement call on it.
>
> Consultant 2

The only newspaper account identified in my sample which explicitly addressed this topic was penned by a renowned climate sceptic. The passage makes clear the issue is one of values, but seemingly only to argue that reaching a decision on the basis of values is a hopeless aspiration, especially when it is aligned with the belief that the climate can be held at an optimum average global temperature:

> Who gets to decide which is the "correct" climate for us to have: the UN; Al Gore; each of the world's inhabitants by popular vote?
>
> *Daily Mail*, November 8th 2009

8.4 Uncertainty

Figure 24: Distribution of 'uncertainty' quotes.

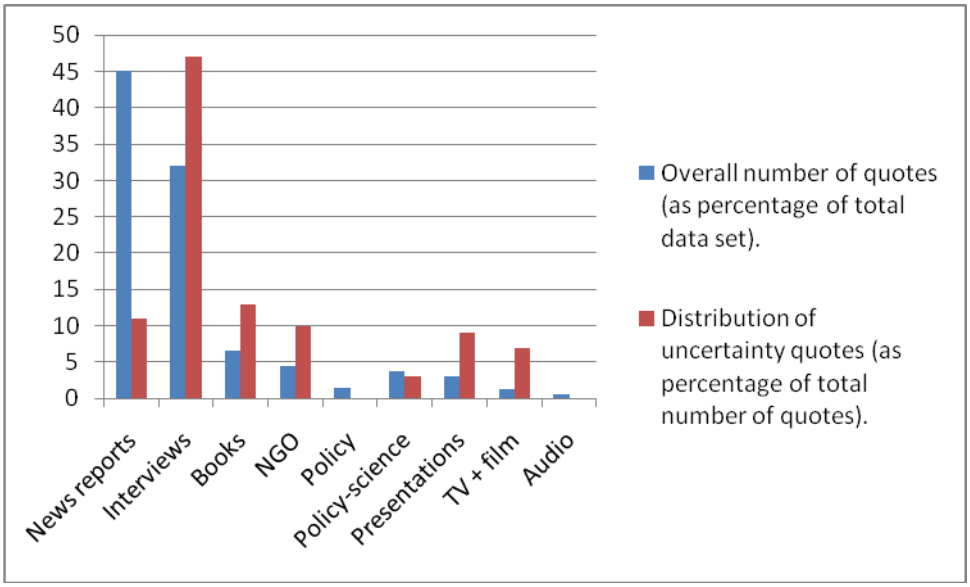


Figure 24 shows a sense of uncertainty in defining a dangerous limit was over-represented in almost all categories bar news reports, where it was greatly under-represented. This aligns with the under-representation of 'anchoring device' codes in newspaper reports. Elements of this pattern were anticipated, most notably the media's avoidance of engaging with uncertainty around the two degree limit. NGO documents were expected to also display this prejudice, but at a quantitative level the data does not bear out this assumption.

A diagram commonly known as the "Burning Embers" diagram, and which first appeared in the IPCC Third Assessment Report of 2001, is widely reproduced across the literature and referred to in interviews as a way of conceptualising the uncertainty which surrounds the defining of a dangerous limit, and even as a means of refuting the role of values in determining a dangerous limit[126]:

> I even remembered drawing one of those burning embers which is a difficult thing to do because there's a lot of, you know, they are doing a lot of expert guesses which they tried to do very, very thoroughly having a whole round of literature. Then you see it across the board, the different impacts that you can get and the different uncertainties there. They are all on the table by the IPCC and others, and you see that when you visualise it you see, you get the

[126] See Appendix 2 for an example of the 'burning embers' diagram.

> problem somewhere between 1 and 2.5 degrees you see. And the IPCC have done this with the burning embers graph themselves, and then you could say ok, what kind of value judgement could be behind 1.8 and 2 degrees? I think that it doesn't really matter much.
>
> Policy/science actor 6

> So, I mean, I'm sure I'm not telling you anything new, but if you go back to that burning embers diagram there seems to be a point where impacts are worse than they would be, you know, below that threshold.
>
> Campaigner 11

This faith in these diagrams is not shared by one of authors of the diagram:

> When I was involved in as a co-ordinating leader and author in the IPCC third report we came up with what is now called the burning embers diagram. So you have five categories if you like. Threatened ecosystems, for example like coral reefs. You have risks of extreme weather, and you have large scale discontinuities like melting of the ice sheets. That was our colour coding at the time based on the impacts research. Ok yeah, it's a compromise yeah, so of course we will lose all the coral reefs if we go up to two degrees or most of them, but who needs coral reefs anyway? But we will at least save the Greenland ice sheet blah blah. So in the end this is a good political compromise, but if you look at the recent research that was published in PNAS this year by Smith and others then all the red colour is coming down in all the columns. This is a quite a dramatic finding and ten thousands of studies have gone into that. This is the stark evidence that 2 degrees is certainly not a very good line.
>
> Schellenhuber, 4 degrees conference keynote speech, September 14th 2009

Uncertainty about the nature of a dangerous limit is often discussed with reference to uncertainties about climate sensitivity:

> The new scientific findings seriously question at least three of the basic assumptions underpinning the UNFCC-led negotiations: first, whether it is at all possible to stay within the two degree Celsius target if the goal for

> negotiations is to reduce global emissions by half by 2050; second, whether the two degree Celsius target is sufficient to avoid "dangerous climate change"; and third, whether we have already reached a danger zone today in terms of concentration of greenhouse gases.
>
> The Tallberg Provocation, 2009: 18

> You hear a lot of numbers bandied around in climate change debate of stabilisations of atmospheric concentrations; 450, 500, 550 CO_2 or CO_2 equivalent. Make sure its CO_2 equivalent when you're talking about it because that's the important one. 450 seems to be the figure of the moment, that is seen to be safe but unfortunately that only gives us a 20% chance of avoiding the 2 degree tipping point, 20-30% chance. That's not really good enough. We need to be stabilising those rates at 400 or less, currently we are at between 430 and 459.
>
> Zero Carbon Britain presentation, Climate Camp, June 2007

> Which target are we aiming for: 2c, 350ppm, 450ppm, 50% of all carbon emissions? Different global warming limitation targets are often referred to, but what do they really mean?
>
> Arthus-Bertrand, 2010: 148

> One of the great unknowns in climate science is just how high temperatures will rise for a given atmospheric level of greenhouse gases. The European Union has set a policy target of preventing a global rise of more than 2C; but precisely what needs to be done to achieve that target in terms of restraining emissions is unclear.
>
> *BBC News online*, 30th January, 2006

That uncertainty is subjective was evident from the following comments:

> I don't know enough and neither does anyone else frankly.
>
> Campaigner 6

> No one actually knows what the tipping point of climate change is there are so many ideas on where it is or indeed whether we've already passed it.
>
> Science/policy actor 5

> I think it's a very interesting question, how is it that 2 degrees has become enshrined as a dangerous limit when you know when you look at the fact that there is all this uncertainty, all these different voices calling for different targets there's just so many uncertainties.
>
> Climate scientist 4

> Obviously we are dealing with significant uncertainty. Whether we can sit around and say 2 degrees warming is going to be ok instead of 5 degrees warming. I don't know how relevant that actually is due to the level of uncertainty there actually is surrounding with what changes are associated with what temperature rises.
>
> Science/policy academic 1

> So we are certain there are thresholds that if you go above so many degrees you are going to bleach coral reefs, take out some species but we don't know exactly where those numbers are. You know Jim Hansen - "1 degree and Greenland is gone". How does Jim know that? Experienced glaciologists don't know that.
>
> Climate scientist 2

8.5 Values

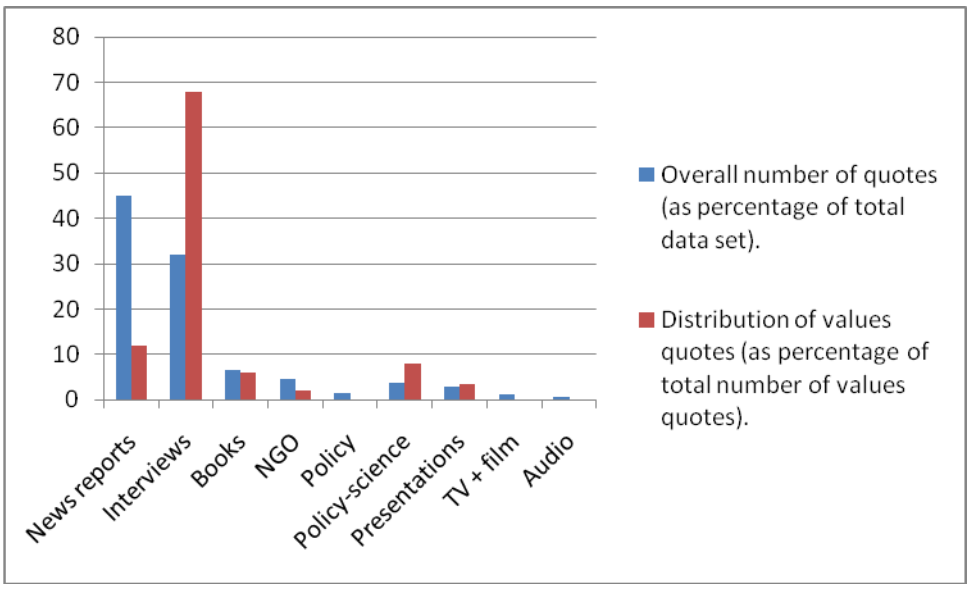
Table 17: 'Values' codes.

Codes	*Number of quotes*
Acceptable	21
Value choice	16
Tolerable	13

I here examine quotes which, rather than describe the two degree limit as an immutable law of nature which divides safety from danger, explicitly identify the limit as a choice derived from a normative vision of the future. Such perspectives are difficult to find in newspaper accounts,

but are over-represented in the interview category and policy-science documents. That discussion of values is such a prominent feature of the interview data indicates that, when asked to justify the setting of a dangerous limit, it becomes necessary to refer to values as an important component of that decision-making process. The policy-science documents in engaging with policy issues must by definition take account of values, if one accepts the idea that the policy arena is where conflict between different values is expressed.

Figure 25: Distribution of 'values' codes.



8.5.1 "Acceptable" and "Tolerable" climate change

I analyse the "Acceptable" and "Tolerable" codes in tandem because they have certain commonalities, over and above being alternatives to descriptions of two degrees as dangerous.

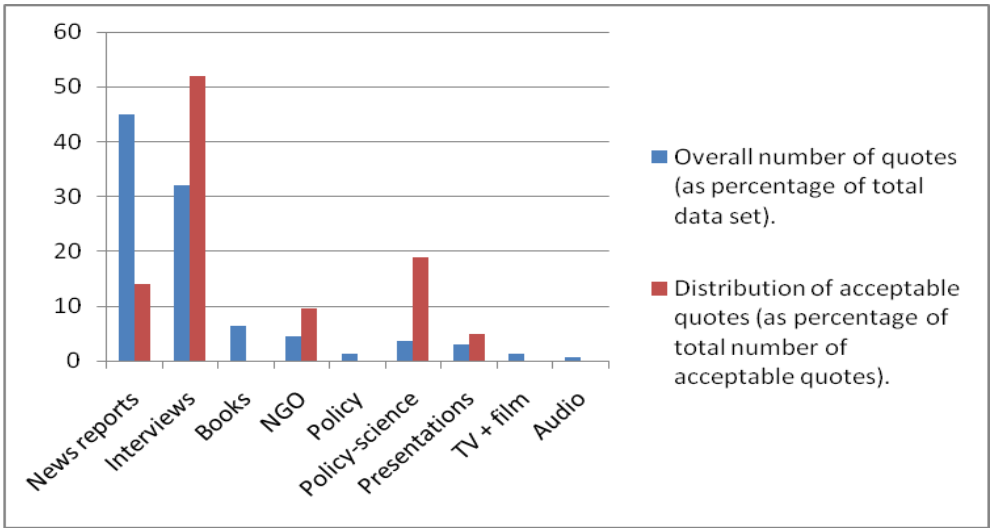
Descriptions of the impacts at two degrees as dangerous is aligned with a quite granular analysis which says "we think this is dangerous because at this temperature there is *x* probability of coral reefs bleaching, glaciers melting etc". However, "acceptable" and "tolerable" refer to more generic scenarios. Acceptability or tolerance is not strongly aligned with specific impacts and probabilities of particular events occurring but instead are words used to describe impacts on humans and ecosystems in a rather undifferentiated manner.

Describing two degrees as acceptable can only be done in light of other exogenous, normative factors, for example as part of an economic cost-benefit analysis. Thus two degrees is acceptable because to try and reach a lower limit would have excessive economic implications.

The implications of exceeding a "tolerable" limit are more profound than either an acceptable or even dangerous limit. As shown previously, dangerous has been derived from a disaggregated palimpsest of different impacts, for example a projected 20%-30% species loss. Whilst it might prove difficult to find voices arguing for that as a desirable outcome, it is not described as spelling the end of humanity or modernity. Conversely, describing two degrees as the limit of tolerability seems to indicate that above two degrees conditions become intolerable. Because the intolerable conditions could not be escaped, one must conclude that intolerable means terminal.

Figure 26 shows that, quantitatively, there are similarities in the distribution of these quotes across the document families. "Acceptable" and "Tolerable" were both under-represented in newspaper articles (14% and 23% respectfully) and over-represented in interview documents (52% and 38%) and policy-science documents (19% and 23%). In this sense they are aligned with the overall pattern for the "Values" quotes.

Figure 26: Distribution of the 'tolerable' and 'acceptable' quotes combined.



Acceptability is sometimes used in discussion of what sort of limit would be acceptable to policy makers, rather than what are acceptable climate risks[127]:

[127] One of the primary complaints from actors working to promote or enact climate policies is the perceived unwillingness of the public to agree to the necessary lifestyle changes. From this perspective political parties are proxies for public opinion; no party will implement stringent emission cuts because they will be voted out by the public. Using Dryzeks' model of core and peripheral norms in policy making, the only targets acceptable to policy makers are targets which do not interfere with the fulfilment of economic norms (2003).

> It is very difficult to obtain a measurable target that could be relatively acceptable to most governments around the world and which could set effectively an aim for climate change mitigation.
>
> Science/policy actor 3

> Certainly at the time when the EU first adopted it I think they genuinely did believe they were adopting a safe threshold and it was also a politically acceptable threshold. In my experience, at least in the whole climate change debate, the science is always filtered through a lens of what is politically acceptable, which is part of the problem of the crisis we face I think.
>
> Green Party MEP

> When Miliband was Secretary of State, he really got the science, he really got the urgency. That's the impression I got from all the people at DEFRA who worked directly with him and briefed him. The constraint comes when you bring it up to the level of national politics and what is acceptable politically to follow through on domestically.
>
> Science/policy actor 1

With respect to the impacts of climate change itself, "acceptable" seemed to be a word favoured by scientists and others working closely on the defining of limits. The following quotes come from presentations given by two of the most senior actors working at the policy-science interface:

> We can tell you what the risks are, but we cannot tell you what's acceptable. Therefore it's a value judgement.
>
> Watson, Darwin lecture, 14th March 2010

> This report was in a sense supporting the view of the scientific community that 2 degrees is in a sense is the maximum that we should accept.
>
> Schellenhuber, 4 Degrees conference, 14th September 2009

Elsewhere “acceptable” was used as a direct substitute for “dangerous”[128]:

> I think NGOs have crowded round the 2 degrees because at least after that there’s dangerous climate change there’s unacceptable climate change ahead of that.
>
> Campaigner 1

> Another interesting indicator is the rate at which the scientists themselves are getting bleaker: 90 per cent of them, according to two recent polls, don't believe the world can attain the emissions targets that will keep warming to an "acceptable" two degrees this century.
>
> *The Independent on Sunday*, August 30th 2009

> What science alone cannot tell us is what should be considered “acceptable risk”, or alternatively, in the language of the United Nations Framework Convention on Climate Change (UNFCCC), what is “dangerous anthropogenic interference with the climate system”.
>
> Baer and Mastendera, 2006: 6

> Well, in the first report we did it roughly we had the two different dimensions. As I said, the two degrees and the point two and we asked for a long term acceptable limit and this long term acceptable limit for absolute temperature was derived from, well, keeping the natural surrounding roughly intact.
>
> Science/policy actor 6

> That aspiration was rooted in the soundest science available at the time, which suggested that this level of cuts was necessary to contain temperature increases below a 2°C threshold (above pre-industrial levels) beyond which risks were considered to be unacceptable.
>
> Don’t give up on two degrees, 2007: 1

[128] In some of these quotes the word acceptable is placed within quotes. This is a noteworthy activity, which I discuss below in analysing the use of quotes when discussing safe and dangerous climate change. The points I make there are equally applicable to the use of quote marks around the word acceptable.

> There is now agreement in the G-20 that to avoid dangerous climate change, warming should be limited to 2°C or less above pre-industrial levels. Greater warming will lead to unacceptable levels of climate impacts and is more likely to trigger accelerated or irreversible environmental change.
>
> AVOID website, 2009

The German Advisory Council on Global Change tends to use "tolerable" and "acceptable" interchangeably:

> We asked "what are the impacts that climate change may have" and then asked "what kind of impacts are we willing to tolerate or how many or where's the limit where impacts actually become intolerable?"
>
> Science/policy academic 6

> Warming of more than 2°C (relative to the pre-industrial value) and/or a warming rate of more than 0.2°C per decade constitute climate changes that are absolutely intolerable.
>
> WBGU 1997: 13-14

News reports, in much the same way as was done with attributing the idea of two degrees as dangerous to science, see tolerable limits as scientifically defined:

> So the world has effectively adopted a target of 450ppm, which might be achievable and still provide a fighting chance of keeping beneath the 2C level ("the best we can do, while being the worst we can tolerate'', as Prof [sic] Holdren put it yesterday).
>
> *The Daily Telegraph*, July 10th 2009

> The overwhelming scientific consensus remains that if we continue to release carbon dioxide into the atmosphere at the same rate that we are today, the rise in world temperatures could be far higher than the 2 degrees that is seen as more or less tolerable.
>
> *The Independent*, December 7th 2009

> Only then, say scientists, will it be possible to prevent global temperatures from rising by 2 degrees Celsius by the year 2100. This figure, they argue, is the maximum warming that our planet can tolerate.
>
> *The Observer*, November 1st 2009

8.5.2 Value choice

The following quotes consciously reject the role of science in defining dangerous climate change:

> I think, and many other scientists think, it's up to political process or some sort of decision making process to determine what is dangerous because there is a value judgement involved. There's a strong component of interest and values in the determination of what's dangerous. Even if there were no uncertainty around the estimates of impacts or the costs of mitigation, it would be values not science that lead you to decide a particular target constitutes a dangerous limit.
>
> Climate scientist 4

> How should we define "dangerous"? A small chance of a serious loss of welfare (a big chance is silly, not dangerous). As welfare can only be defined at an individual level, and perhaps in a democracy, dangerous is undefinable (sic) at a global scale.
>
> Economist 1

One respondent identified attitudes to risk as a determinant within the science community itself, rather than simply a filter applied by policy makers externally to the science:

> Working group 1 people are type 1 errors people. Their risk aversion is on the science not being wrong rather than it being a planetary mistake, which is a value judgement about the degree of risk aversion.
>
> Climate scientist 1

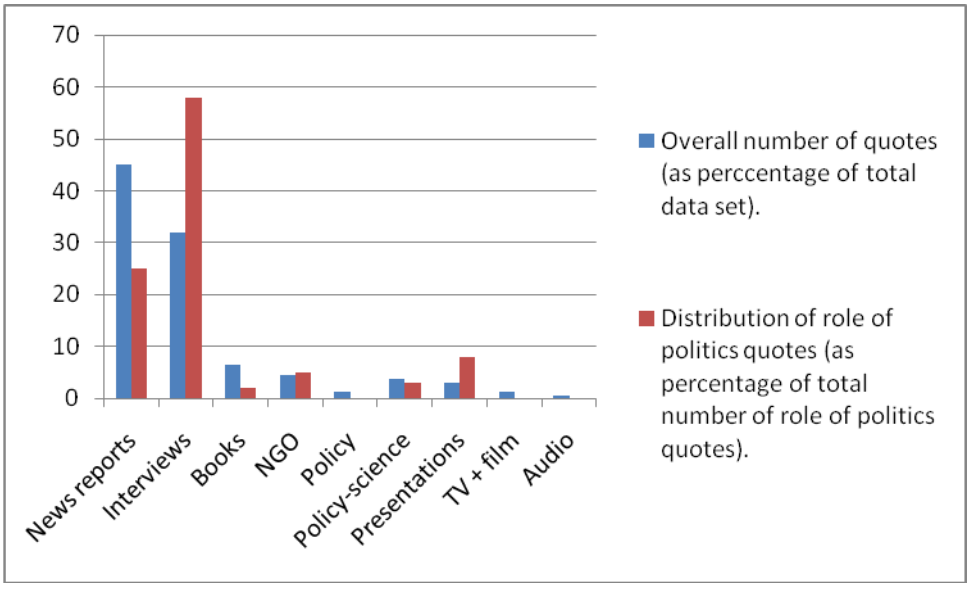
8.6 The role of politics

The idea of defining limits as a value choice leads inevitably to discussion of politics, politics being the activity which in a democracy, according to pluralist accounts, decides between different value choices. There were three codes assigned to this category. As well as quotes which identified the need for climate change responses to be framed in a policy relevant way, there were twenty quotes which defined the two degree target as a product of EU policy making and ten quotes describing the limit as one defined by politicians rather than scientists. Commentaries privileging the role of politics in target setting were over-represented in interviews and presentations, but under-represented in news report accounts.

Table 18: '*Role of politics' codes.*

Code	*Number of quotes*
Policy relevance	31
EU 2 degree leaders	20
Political target	10

Figure 27: Distribution of 'Role of politics' quotes.



My sample contained 31 quotes which claim that any discussion of limits must be policy relevant. 30 of these came from the interview document family. Policy relevance firstly requires the phenomenon to be constructed as an object amenable to management through

existing policy frameworks. This generally means that it is enumerated as an essentially quantitative phenomenon.

Secondly those numbers, in order to be relevant, must be reasonable, i.e. must take account of the other issues to which the policy framework must respond. The commentaries analysed here reveal a process similar to that highlighted by Crenson (1971), and discussed in the literature review. According to Crenson, the demands made of policy makers by environmental campaigners is pre-defined by the litigants' recognition of what sort of demands are likely to be considered reasonable. If applied to the setting of a two degree dangerous limit, one must be sensitive to the possibility that deliberations on dangerous limits have been shaped by preconceptions about policy demands. The idea that the knowledge production process has from the outset been defined by the need for policy relevance is borne out by the following quotes:

> I'm trying to remember the dates, probably about '96, '97. In the UK at least there were attempts at least to actually define a safe limit and, you know, use that as a kind of policy threshold of some sort. Originally they saw it as a range, but to get more towards practice and commitment in policy terms you can see how it makes sense to say this is more like the kind of target we have got to avoid and treat as a threshold. So let's fix a figure and then, like you say, it becomes a kind of, it's a focal point around which everyone can concentrate. Originally back in about '97 when I actually went to one of these NERC meetings the scientists were all there deliberating about the policymakers, saying "the policymakers have asked us to give them, you know, some definition of what would count as safe or unsafe climate change, where is the limit?" and I asked "are you sure that you can actually pretend to answer that question? Why don't you say to the policymakers we can't answer that question? Wouldn't that be a scientifically sound and reasonable thing to say on the basis of existing science", (and probably based on future science as well, but leave that one out for now). And they didn't want to do that at all because they were scared it would undermine their funding and influence. So they are already operating with assumptions about what policymakers would take on board
>
> Science/policy actor 2

> I've been dealing with the issue of meaningless numbers for so long. The

> environmental community, and I will count myself part of them, though from the scientific side, have long realised that in the political world that statements like "we have to do as much as we can as quickly as we can as fairly as we can and as cost-effectively as we can" is not so cloutful, if I can coin a word, inside of parliaments, Whitehouses, 10 Downing and Congress as "we cannot exceed 2 degrees above pre industrial otherwise the world turns into a climatic pumpkin". And back in 1988 environmental groups were arguing we must have a 20% reduction in our emissions. Now I was at a meeting where that was first proposed and I said "wait a minute guys we haven't looked at what the costs and the benefits of this are". I'm not talking about narrow economic views, but you can't just pluck a number out of your head, and they said "no we have to have a number because without a number we can't get their attention" so I understand there is a political strategy in approaching this in terms of number
>
> Climate scientist 2

These comments indicate that in the decade between 1988 and 1998 arguments were as much about whether there is even such a thing as a quantifiable dangerous limit, and that the pressure for quantifying the limit came from the policy side of the debate.[129] Given the need to be heard by policy actors, the uncertainties surrounding projections of future impacts, and the requirement to respond to already present norms, policy advisors defended their backing of a questionable limit on the basis of pragmatism:

> There's a practical level isn't there? If you say "one degree", if you costed the repercussions of that globally you'll be laughed at. We are struggling to get the message heard at 2 degrees so I think there's a pragmatic element there, but I think it's important we remember all the time that this is a pragmatic thing.
>
> Climate scientist 1

> I think when you are trying to have some sort of policy impact you have to be fairly pragmatic about the targets you are using and to have some point at which you can begin to engage. I've never really looked into the debate leading into that adoption of 2 degrees as a target so exactly how pragmatic that target is in terms of the debates that were being had I don't know. My instinct

[129] Though of course, the scientists themselves are working within a quantitative epistemology, so resistance to the belief in a quantifiable limit might have been muted.

> is that it's just a pragmatic point at which we can aim. DEFRA are deeply pragmatic people who work with politicians who are politically constrained in what they can do.
>
> Policy/science actor 1

Given that, on the international stage, it is the EU which has been leading the attempts to legislate on the two degree limit I looked to see to what extent the data described two degrees as a product of EU policy, rather than scientific fact. The largest source for these quotes was newspapers, which supplied nine (45%) of all references to the EU as the source of the two degree limit:

> The EU got hung up on numbers, that was sort of a mixture of "that's the best we can do" and "God we don't want it any worse than it is" and I am very sympathetic to that view.
>
> Climate scientist 2

> Its two major findings will show that mankind is responsible for creating the gases causing climate change and that the planet may suffer a three-degree rise in temperature. This would be one degree higher than the "danger level" warned of by the European Union for creating the unbearable heat wave summer witnessed across the Continent in 2003.
>
> *Sunday Express*, January 28th 2007

> The New Economics Foundation warns that global economic expansion is not possible if the world is to restrict the temperature rise to 2 degrees - the EU's agreed political objective.
>
> *The Guardian*, January 25th 2010

> But the Met Office's new prediction hits directly at the principle guiding all those hoping for an effective agreement, with the European Union in the lead: that of stopping the warming at two degrees Centigrade above the "pre-industrial" level.
>
> *The Independent*, March 9th 2009

8.7 The role of economics

One of the most important norms that policy actors are responding to, after the promise to keep their citizens safe, is the economic one, namely the need to maintain the conditions for economic growth. Though knowledge of the conflict between economic growth and environmental degradation is commonplace, it is important to understand the extent to which this tension is seen as relevant to the setting of the two degree limit. The rather low number of quotes discussing this issue is surprising given the assumed importance of economic considerations to the setting of environmental policy. An aggregate quantitative analysis reveals a weighting towards policy, policy-science and interview document families for this data (albeit based on small numbers). The codes listed below required the imposition of clear categories on subject areas with rather fuzzy boundaries (for example any assessment of economic feasibility is, in essence, a cost-benefit analysis). In the qualitative analysis I discuss "Economic development" separately from the other three codes, which are discussed as one body of quotes.

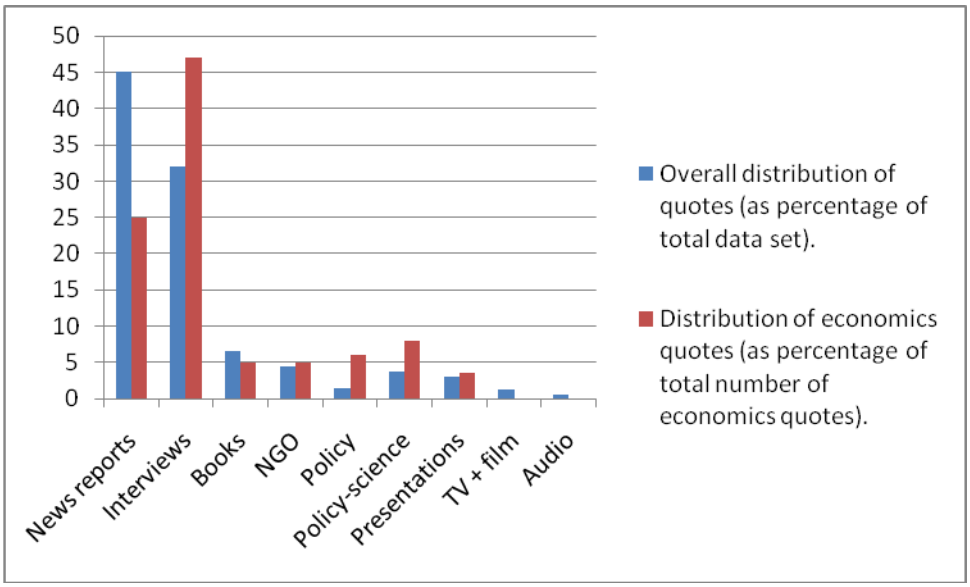
Table 19: *Economics codes.*

Codes	*Number of quotes*
Economic feasibility	12
Economic implications	10
Economic development	7
Cost-benefit calculations	5

The economic implications of the two degree rise at a policy level normally took the form of a comparison between the cost of the two options - avoiding breaching the two degree limit or the effect of two plus degrees of warming on the global economy[130]:

[130] The primary exemplar of this approach is the Stern Report. Whilst this is the most noteworthy cost-benefit analysis of the costs of mitigation, the analysis operates on a ppm CO2-e basis, arguing that stabilising at 500-550ppm CO2-e would cost 1% of annual global GDP, whilst a 2 to 3 degree rise would reduce global economic output by 3% (2006, xii). However, as the proposed 500-550ppm CO2 -e is likely, in Stern's own calculations, to lead to rises of over 2 degrees it is difficult to understand what case Stern is actually trying to make. On the terms of the search criteria used for my sampling, the focus in the Stern report on ppm rather than warming means the discussions in that report largely fall outside the remit of my research.

Figure 28: Distribution of 'economics' quotes.



> There is increasing scientific evidence that the benefits of limiting overall global annual mean surface temperature increase to 2°C above pre-industrial levels outweigh the costs of abatement policies.
>
> Communication from Council of the European Union, February 2005

Actors working at the policy-science interface argue that the language of economics supersedes scientific projections of impacts on ecosystems and human well being. Commenting on the coverage given to the Stern report, one scientist complained:

> It's only when the science is converted into economics that everyone thinks "oh wonderful, marvellous". The fact that scientists have been saying for a long time that this is a serious issue that we need to think seriously about was just ignored.
>
> Climate scientist 1

Overall, concerns about economic norms were voiced with respect of general environmental legislation, rather than the two degree limit in particular:

> With a lot of the work you get asked to do at an EU level or UK level there's always some kind of caveat about what the business opportunities associated with that will be for the UK or plc, especially in the EC. There's never anything

> that comes out of the issue of the environment that doesn't ask you to consider the competitive implications for EU companies.
>
> Science/policy actor 1

> The trouble is, who makes decisions? Mainly treasury ministers. Of all ministers in government, other than the head of state the most powerful is the man who controls the budget.
>
> Watson, Darwin lecture, 14th March 2010

> On the one hand you have Gordon Brown saying climate change is the biggest threat we face and on the other hand he will give the go ahead for the 3rd runway at Heathrow, and say actually the economic demands are far more important than this climate change thing.
>
> Green Party MEP

Only one campaigner was specific in his criticism of how economics had shaped the two degree debate, the same campaigner who had been very critical of other elements of the two degree debate:

> The idea that, you know, various realities can be served, commensurated (sic) and reduced in a way that makes them market friendly or cost benefit analysis friendly, or economics friendly, the 2 degree idea falls into that category. Obviously the transgenesis (sic) of the 2 degree ideas are ok well, give us an idea of what we have to do to avoid certain kinds of catastrophe with a 99% probability. That comes from an economic or economistic (sic) I should say thinking.
>
> Campaigner 12

It is in light of these comments that we can understand the EU's conditionality on the two degree limit; it will only be done if it can be afforded:

> Limiting global warming to 2^0C is both technically feasible and economically affordable if the international community acts swiftly.
>
> Communication from the Council of the European Union, January 2007

The other significant economic issue raised in discussion of the two degree limit was the familiar concern about the impact of reaching such a limit on the development of the Annex 2 countries. Perhaps inevitably, such concerns were made primarily by campaigners and in NGO documents, with only one reference in a newspaper report:

> "You should not target China to fulfil the two degree target. That is just a vision. Reality has deviated from that vision," said Dai. "We do not think that target provides room for developing countries".
>
> *The Guardian*, September 17th 2009

> Look at the position of many developing countries. They are concerned to not take on burdens that would slow their economic growth.
>
> Climate scientist 4

> We need to do all we can to limit global warming to well below 2°C, to protect our economies and businesses from dangerous climate change.
>
> WWF Pacific.org, 2003

One campaigner saw arguments for limits such as the 1 degree limit called for by the government of Bolivia as a veiled attack on capitalism:

> It's such an ambitious aim that it's impossible possibly probably both politically and physically. And so you have that dynamic within the temperature debate in the negotiations as well; to what extent does Bolivia really care about limiting warming to 1 degree and to what extent are they fed up with a global economy focussed on capitalism, which is most of what you hear Morales talking about?
>
> Campaigner 11

8.8 Distancing devices

In interviews I encountered what seemed to be attempts to distance the speaker from too close an association with the idea of a two degree dangerous limit. These encounters sensitized me to the possibility that attempts to avoid ownership of the idea would be an important element of the black-boxing process I theorised was occurring in commentaries on

the two degree limit. This section of the analysis examines the forms such distancing devices take, and in what document families that could be found.

Table 20: 'Distancing device' codes.

Codes	*Number of quotes*
'Dangerous'	11
'Safe'	11
Defending one's credibility	3

Figure 29: Distribution of 'Distancing device' quotes.

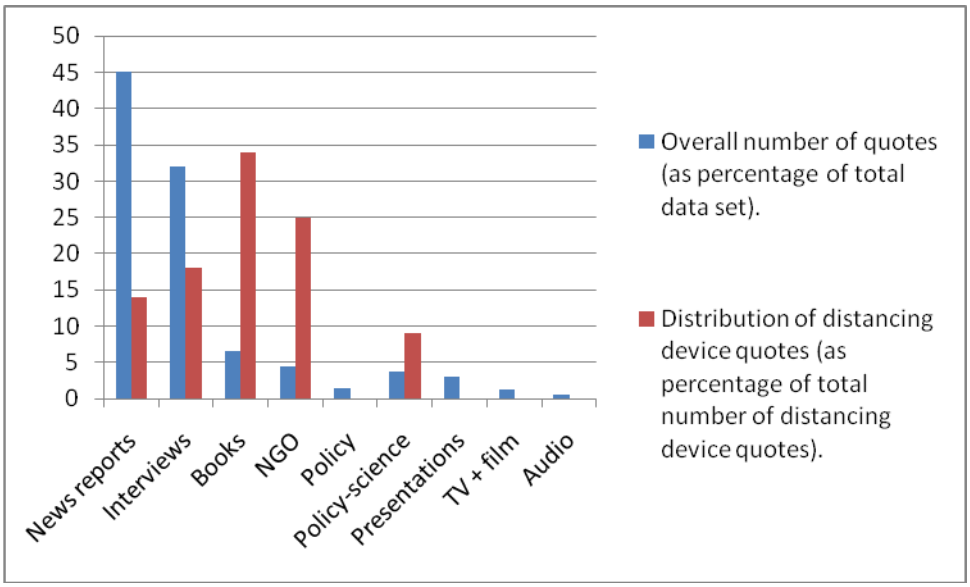


Figure 29 shows that this distancing is, proportionally, most prevalent in the most persistent commentaries. I interpret this as indicating the author or speakers lack of belief in the veracity of describing two degrees of warming as a line separating safe from dangerous climate change. There were 22 examples were the words safe and dangerous being placed inside quotation marks, which I characterise as a distancing device. The use of quotation marks highlights the problematic nature of these words, whilst also legitimating use of the terms, as these quotation marks appeared in passages that advance their argument on the basis that there is such a thing as a dangerous limit:

> If the computer models are right, and we still have time to cut back emissions in order to avoid "dangerous" levels of warming, then we can still aim for a "safe" landing within the 1-2 degree corridor.

Lynas, 2007: 265

> Many previous attempts to decide how far we should allow our climate to go began with the idea that we should stop climate change before it becomes "dangerous" All things being equal, to keep the "danger" as low as possible we would pick the lowest possible rise, in other words set a temperature limit of 2°C.

King and Walker, 2008: 89

> Two degrees, because it has been widely recognised by climate scientists as the critical threshold, has sometimes been characterized as a "safe" level of warming.[131]

Monbiot, 2007: 17

> Until now, the most widespread interpretation of "dangerous climate change" has been the definition of the "2°C threshold". The goal of holding global average temperature increase to less than 2°C above the pre-industrial level (compared with the current increase of roughly 0.7°C) has been a stated objective of the European Union, including the UK government, for a number of years. A discussion of the justification of the 2°C threshold would take us far beyond the scope of this paper, but based on earlier work (Baer 2005, Retallack 2005) we suggest that the likely and possible consequences of exceeding the 2°C threshold warrant seeking a high to very high likelihood of staying below it.

Baer and Mastanderea, 2006: 6

> The government is committed to avoiding what has become known as "dangerous climate change"; in other words, keeping the average global temperature increase to below two degrees centigrade on pre-industrial levels.

World Development Movement, 2007: 1

[131] Despite the language used here, which distances the author from the claim that two degrees is indeed a safe limit, the book's argument is premised on the desirability of a two degree limit, anything higher being seen as a threat to the industrial order to which the author expresses an attachment (2007: xii).

My sample produced two examples of this practice in newspaper reports. The first is from a newspaper generally sceptical of claims about anthropogenic climate change. In this instance the quotation marks fulfil the same function as in other texts, though perhaps here it is intended to undermine rather than support ideas of dangerous climate change:

> This would be one degree higher than the "danger level" warned of by the European Union for creating the unbearable heat wave summer witnessed across the Continent in 2003.
>
> *Sunday Express*, January 28th 2007

The second came from a BBC online news story which was discussing the uncertainties of climate science:

> A major new report commissioned by the UK government suggests it is unlikely that "dangerous" climate change can be avoided.
>
> *BBC news online*, 30th January 2006

In three interviews it was apparent that care had to be taken in discussing dangerous climate change limits as ones standing as a reputable actor in whatever field of endeavour the respondent was working in was at stake if one made too definitive a statement, including advocating for two degrees on the basis of science:

> I participated in developing positions for the organisations which advocated for particular targets and as part of that advocacy would have made statements to the media and so forth to the effect that our organisation was backing the two degree target. But I did not personally, in my role as a scientist, sign any umm documents that get circulated advocating a particular level. I did feel, I guess, it was important that if I wanted to maintain a role in the research world I had to be very clear about what role I was taking at any moment.
>
> Climate scientist 4

> One of the things is trying to guard one's credibility in these areas, trying to protect it so I, um, I mean I suppose where does one regard ones credibility standing? So my basic approach is to try to find some things to comment on, to find the things externally one can position oneself on, so I think referencing the

> Exeter conference as footnote I think in retrospect I could amplify that a bit in the text. You know the Exeter conference I think said 80% reduction, um the purpose of the argument was not primarily to argue for a reduction.
>
> Consultant 1

> Well the decision was definitely not done by the council to write the 2 degrees into law not in Germany, not at the European level but this was done by a democratic government.
>
> Policy/science actor 6

This latter statement is an attempt to draw a clear distinction between the work of the WBGU and the decision to set the dangerous limit at two degrees, a distinction which I have sought to argue is less apparent than this statement would indicate.

8.9 Discussion

This section of the analysis has brought into sharp focus the themes identified previously and has highlighted the clear divide between broadcast commentaries and interviews in their respective justifications for the two degree limit.

Policy makers share the media's demand for short, simple and stable summaries of climate change scenarios. Interview data indicates that there has been an element of co-production of knowledge around two degrees between scientists, policy-makers and actors straddling the two camps.[132] Quotes from climate scientists present at some of the early meetings indicates there was no shortage of scientists willing to tell policy makers what they wanted to hear, namely that there was a calculable and quantifiable single dangerous limit.

A wide range of different perspectives and rationales for defining two degrees of warming as a dangerous limit have been turned into scientific fact in a large number of public commentaries,

[132] In an interview with one researcher who worked across the policy-science divide the idea of the co-production of knowledge was discussed. This actor was predominantly on the science side and found himself working with water managers in the South-East of England, looking at how climate change impacts figured in long - term planning of water supplies. It was apparent the planners had more faith in the science than the researcher could share:

> So I worked with water managers in a collaborative sense. Because I approached them they were always a little bit suspicious in terms of getting access to their data and plans and the research question there was, given that there is uncertainty about climate change and given that water managers are planning for the next 25 would they change their decisions if they actually recognised there was a lot more uncertainty about the future. I wouldn't go so far as to call it a co-production of knowledge but certainly going in that direction and, I would argue, policy relevant. Certainly I'm a little more cynical about it now because you know having been slightly more reflective about both my work and other work around I realise that science has some serious limitations.

which use science as shorthand for an objective truth and to persuade their audiences of the reality of a dangerous limit to climate change. This description of the two degree limit was evident in all commentaries except interviews, where the two degree limit was almost invariably identified as a value choice, not an objective fact.

Perhaps because the empirical basis for the two degree limit is so shaky, and because there are perceived to be industrial interests opposed to the defining of a dangerous limit, the two degree limit was described as a precious and fragile concept that presented the last best hope for developing meaningful climate change policy. It was an idea best not exposed to the bright light of enquiry and not discarded unless a better alternative was available. Interview data demonstrated a recognition amongst the majority of respondents that targets generally are vital to the construction of climate change as a phenomenon amenable to management through pre-existing policy frames.

Theoretically, much is to be gained from combining the idea of anchoring devices with institutional and elite theory. While Moscovici described anchoring as a process individuals engage in when faced with a novel threat, my analysis shows that, as far as climate change is concerned, this process of making the unfamiliar familiar through recognised symbols and frames was a top-down process, that once climate change had been quantified, this construction could then be communicated to the broader public through the media and NGOs.[133]

As this analysis has shown, calling on science to justify the two degree limit has created difficulties. An anchoring device must be stable, the two degree limit must remain. Yet this very same science has pulled the rug from under the feet of those advocating for the two degree limit, with much research indicating dangerous impacts will become apparent at lower levels of warming. This new information has to be ignored by the two degree advocates, who proceed in wilful ignorance and where that fails rely, in the words of one politician, on deceit.

[133] One respondent discussed this as an interaction between external, expert definitions of risk and internal definitions of risk experienced by the individual. For this respondent understanding the processes at work requires application of the social amplification of risk framework (see, for example Kasperson et al., 1988).

Chapter 9

Discussion of findings

9.1 Bridging the gap

Dryzek has identified four categories of environmental discourse: survivalism; environmental problem solving; reformist and green radicalism (1997). The green radicalism discourse, as essentially anti-industry, is not a discourse identified in my data. My analysis has focused specifically on commentaries about the two degree dangerous limit. The absence of green radical perspectives from these commentaries indicates that the two degree discourse displaces such accounts. This finding would seem to confirm the elite theory frame employed in my analysis, which argues that constructing climate change as a phenomenon with a two degree dangerous limit is an ideological act designed, in part, to legitimate modernity, as defined in this thesis.

'Survivalism' is the category Dryzek uses to describe the limits discourse. Survivalism assumes that drastic action is needed to prevent exceeding natural limits, and thus global disaster (1997: 12).[134] 'Environmental problem solving' is a discourse broadly sympathetic to institutionally embedded responses, based on enlightenment ideals of the individual as a rational actor. The primary agent of change is the expert. 'Reformist' discourses are aligned with the goals of sustainability and ecological modernity, which eschew ideas of limits. The two degree limit validates all three of these discourse categories. The connection with the survivalism discourse is obvious - it is the concern with catastrophic, runaway climate change which is given as the motivation for observing the two degree limit. Public commentaries on the two degree limit rely on institutional expertise for validation, an approach which is characteristic of the environmental problem solving discourse. Though Dryzek's reformist category does not turn to discussion of limits to justify its agenda, in positing the need for sustainable development it is closely aligned with the narratives associated with the two degree limit in so much as the two degree limit provides the ontological and temporal space for mitigation strategies that are reformist rather than revolutionary.

In their revised analysis of repertoires used to describe future climate change scenarios, Ereaut and Segnit identify two broad discourse categories - 'Alarmism'[135] and 'Resolve' (2007). Ereaut and Segnit identify three different forms of alarmism; alarmism, sober alarmism and conservative alarmism. Alarmism per se is seen as the language of shock, which leaves no

[134] Dryzek also includes 'Promethean' perspectives within this category, to describe those texts which argue there is no such limit, on the assumption that the earth's natural systems are more robust and regenerative than implied by a limits discourse.

[135] Ereaut and Segnit are at pains to differentiate between 'alarmism' – 'the often unwarranted exciting of fears or warning of danger' - from 'alarm' - 'fear resulting from the perception of imminent danger'. However it is not clear how they are able to differentiate between warranted and unwarranted fears, at least in respect of future climate change impacts.

room for human intervention; it's already too late. Conservative alarmism recognises but dismisses the dangers. Sober alarmism 'is the language of seriousness, numbers, likelihood and proof, which suggests there is more room for human intervention' (2007: 6). Amongst the resolve repertoires, Ereaut and Segnit identify establishment techno-optimism as a discourse that assumes that the market and industry can provide the solutions. Non-establishment techno-optimism is seen to deal in more concrete discussion of numbers and targets, and has a rather Panglossian approach to the promises of technology. The two degree discourse displaces the 'too late' message of alarmism to a two degree future. This displacement activates the sober alarmism and techno-optimism discourses, which argue for human agency, expressed through the development of new, and more ecologically sensitive application of various technologies. The human agency allowed for by the two degree limit is essentially technological because it is an instrumentalist frame demanding global monitoring of emissions through the use of diverse but complex technologies, ranging from domestic energy use meters through to networks of satellites orbiting the earth.

Examining the two degree limit idea in light of these two categories of discourse shows that not only does the concept crowd out green radicalism discourses, but it acts as a bridge across a majority of the other discourses. In providing a unifying theme, the two degree limit accommodates a range of different perspectives, allowing a diversity of different approaches to be brought to bear on the climate change problem. Lowe and Lorenzoni, in an examination of expert concepts of dangerous climate change, suggest, that the "dangerous" discourse is positive in its ability to draw attention from a wide spectrum of interests and motivations to managing climate change (2007: 143). I argue that the discourse, in constraining debate to those perspectives which are validated by the two degree limit, only serves the interests of the elites proposing the target, and consequently reject the claim that the two degree limit is positive or progressive. Rather than a positive approach, the concept fulfils an ideological function by not only blocking deep green values, but also by encouraging and validating those responses grounded within the paradigm of modernity. Nor has it been a successful strategy, as shown by recent discussions of preparing for four or more degrees of warming. Instead of a useful and rational response to climate change the adherence to the targets agenda is an example of 'that well-documented human response to failure, especially where political or emotional capital is involved, which is to insist on more of what is not working: in this case more stringent targets and timetables, involving more countries' (Prins and Rayner, 2007: 974).

9.2 Static targets and dynamic science

The two degree limit is a broad church, but the accommodation of such a wide spectrum of views means there is a great deal of tension surrounding the interpretation of the two degree limit because the concept - and its anchoring role - is being simultaneously pulled in a number of different directions. This tension is evident both between and within different discourse communities. It is important to explore these tensions, because the idea of a broad political and scientific consensus is one of the more prominent justifications used to support the two degree argument.

My data suggests tension emerging between climate scientists and the policy community on the two degree dangerous limit. The period from 2007 onwards appears to have been a time when diplomatic effort has been directed at getting the two degree limit in place as the corner stone of international policy. Such efforts have meant leaving the concept unexamined, it being enough to simply fix a target. Nonetheless, scientific knowledge of climate systems and the impacts of climate change has not remained static. Whilst explicit scientific validation of the two degree dangerous limit has always been tenuous, what developments there have been in climate science have pushed the danger zone for many ecological systems and areas of human activity below the two degree line (see Appendix 2). Alongside this empirical data from real world observations of existing climate change impacts, climate sensitivity modelling and back casting has been interpreted as suggesting the climate is more sensitive than previously imagined to changes in its chemical composition. Informant elicited data analysed for my research, alongside more recent academic literature, highlights increased concerns about policy actors' claims of a scientific basis for two degree limit. These findings to some extent mirror the results of van der Sluijs et al.'s research into the fixing of the 1.5 - 4.5^{o}C climate sensitivity range. This 'consensus range' had remained fixed for twenty years, despite 'dramatic changes in scientific knowledge and analysis during this time' (1998: 291).[136] The authors conclude the range has remained fixed over this time period because the range holds together a variety of different social worlds, but only by being an imprecise measure which can therefore accommodate differing perspectives and needs (ibid). The authors go on to note that there was no scientific rigour to the establishing or maintenance of this climate sensitivity range. Yet key actors (such as the head of the IPCC) would not be willing to change the range without a robust scientific basis, as absent any such justification, it would be difficult to secure public confidence in any changes (1998: 303). In addition, because the range was not

[136] And indeed remains fixed at this range thirteen years after this paper was published.

established through the application of rigorous scientific analysis, any attempt to revisit the range would require scientists to explain how the range was arrived at initially, and there is a reluctance within the scientific community to have the shortcomings of previous work practices exposed (1998: 305; 313).

The two degree limit differs from the climate sensitivity range in so much as it is a fixed point, not a range. However, the inability of this fixed point to accommodate all perspectives and aspirations against a backdrop of a contested and evolving empirical evidence base explains the development of an informal range that covers claims of a dangerous limit as between 1 degree (Hansen, 2007) and 4 degrees (Anderson and Bows, 2008: EAC, 2009) of warming.

The key strengths of the climate sensitivity range, according to van der Sluijs et al., is not its veracity as a representation of reality, but are discursive and social. These functions are also realised by the idea of a single global dangerous limit. Van der Sluijs et al. describe boundary objects as relatively stable and reproducible ideas which make possible communication between different social worlds. The object does not need to be a fixed value to achieve this, it just needs to be an idea constructed in a fashion which has meaning to divergent social fields (1998: 311). The manner in which the two degree discourse fulfils a boundary object function was explained at the beginning of this chapter, where the two degree dangerous limit concept was shown to bridge various environmental discourses. Conversely, in its role as an anchoring device, the concept needs to be fixed, highly aggregated and multivalent. By being fixed, the concept acts to manage uncertainty by limiting drifting (1998: 312). This notion of anchoring differs from that proposed by Moscovici, though it does not contradict it. The importance of the two degree limit in providing a shared stable meaning to a broad range of epistemic and social communities was confirmed by several respondents from the policy, policy-science, and campaigning organizations examined in my research who felt that, whatever the weaknesses of the concept, it was better than no target at all.

Several texts and informant elicited responses indicated that the dangerous limit could be constructed as a range similar to that used for climate sensitivity. For example, I identified several attempts to compare the dangerous climate change scenario to the idea of speed limits for road traffic. Like a speed limit, the two degree line is not a dramatic threshold above which something bad will happen. Rather, the faster you go, the greater the risk. However, it was felt that communicating dangerous climate change as a range, or in anything other than a simple round figure, would be too complicated. Such narratives indicate that non-specialist audiences (for example, the public) are the intended audience for the two degree message (if the audience is other climate scientists presumably there would be no need to simplify the issue in this way). However, as political parties do not campaign on different dangerous limits targets it

is difficult to understand what the public are intended to do with this information (though one environmental campaigner asserted that it was used to justify to the public the sacrifices and changes they were being expected to make).

Other emerging tensions were also apparent in my data. Contemporaneous to efforts to impose a two degree dangerous limit, there has been a growing awareness amongst scientists that it will be very difficult to meet this target. The inadequacies of the two degree target are further exposed by something of a cultural turn in social science research on climate change, examining the culturally and socially embedded differences in vulnerability to climate change impacts. It is therefore apparent that research in a number of disciplines is undermining the case for a single dangerous limit, of whatever temperature.

9.3 Verbal and textual representations of the two degree limit.

My research also identified a tension between written and spoken constructions of the two degree dangerous limit. Whilst public commentaries from the policy community were relatively uniform in their description of the two degree limit, my research indicates that privately opinions on the subject may differ significantly both from the public positions and from each other. It has been difficult to secure interviews with the relevant policy actors, but the one politician I spoke to believed adherence to the two degree line within policy circles required a collective act of deceit. Additionally the transcript of the Environmental Audit Committee's examination of the Committee on Climate Change's recommendations to the government revealed a great unease about the assumptions that underpinned the two degree recommendation. In 2007 the United Nations Foundation released a report titled 'Scientific Expert Group Report on Climate Change and Sustainable Development' (Bierbaum et al., 2007). This was a multi-authored document which made the claim:

> No one can yet say for certain what increase in global-average surface temperature above the 1750 value is "too much," in the sense that the consequences become truly unmanageable. In our judgment and that of a growing number of other analysts and groups, however, increases beyond 2°C to 2.5°C above the 1750 level will entail sharply rising risks of crossing a climate "tipping point" that could lead to intolerable impacts on human wellbeing, in spite of all feasible attempts at adaptation. Given what is currently known and suspected about how the impacts of climate change are likely to grow as the global-average surface temperature increases, we

> conclude that the goal of society's mitigation efforts should be to hold the increase to 2°C if possible and in no event more than 2.5°.
>
> Bierbaum et al., 2007: xi-xii

Such documents would seem to support the claim that the two degree target is 'where the majority view of the global political and scientific actors appears to be at this time' (Maybe et al., 2011: 11). Whilst the belief that the majority of political actors are supporting the two degree limit may not be contentious[137] the claim of a scientific consensus is less secure. As reported in my data, one of the lead authors for the United Nations Foundation report, Hans Joachim Schellnhuber, in his keynote presentation at '4 degrees and beyond' Oxford conference in September 2008, described the two degree limit as 'not such a good target', which would likely see the extinction of coral reefs.

I interviewed another of the 'Scientific Expert' report's authors, and asked him directly, as a follow on from his previous answers which identified the two degree statement as a value choice, how he reconciled this belief with his involvement in a notionally scientific document which argued for the two degree limit. He replied (by email, as a follow up to our earlier telephone interview):

> This report is of a different character. As described in the Foreword to the report, when establishing the Scientific Experts Group, the UN Division of Economic and Social Affairs requested the panel to make recommendations for action. This charge differs from that given to the IPCC, which is to provide policy relevant information but to be policy neutral (i.e., not advocate particular decisions or policies). In the report itself we attempted to make clear that our role here was different, and that we were reaching a judgment that incorporated our values and made recommendations of what should be done. But I will also point out that we remained true to how we interpreted the available scientific evidence. The sentence you quote above reflects uncertainty, both in its formulation "No one can yet say for certain" and in its use of a range (2-2.5^{o}C) rather than a single number.
>
> Scientist 3

[137] Though how one defines majority is problematic. Many leaders from the global south are arguing for a 1 degree or 1.5 degree target. If one were to measure majority by the number of people represented by these leaders, the idea of majority might prove difficult to justify.

Given the complications involved in the communication of science to non-scientific audiences, it is easy to see how such subtle distinctions between science and values may be invisible to downstream users of such reports, such as the public, but also journalists and environmental campaigners. My data reveals a tension within the scientific community itself, it being unclear where science ends and values begin in the dangerous limits debate. Some scientists at the policy interface do not themselves seem concerned with clarifying this distinction, as this quote from researchers who have been closely involved with the formulation of EU climate change policy shows:

> First, we can acknowledge that the limit was - sometimes inadvertently, sometimes consciously - introduced into the policy debate not by policy makers but by some of us.
>
> Jaeger and Jaeger, 2010: 25

Discourses which proclaim the need to draw a distinction between values and science in the two degree debate thus appear to describe a utopian vision which has not been realised, with scientists happy and willing to promote a value based position cloaked in the mantle of science.

9.4 Two degrees - a gradual or a sudden shift into danger?

One of the most striking tensions between public and background commentaries was between ideas of a threshold as opposed to a continuum of ever increasing danger. This was closely related to another division in the two degree limit debate, between the global North and South. My data showed environmental campaign materials and website statements relied heavily on ideas of distinct thresholds between a stable and a dangerous climate, whether at 1, 1.5 or 2 degrees (or 350ppm eq). However, in interviews environmental campaigners were less forthright about the existence of a distinct point at which the climate becomes dangerous, with a tendency to talk in terms of a continuum of danger. The need to recognise a continuum of danger was driven by awareness of the differences in resilience to climate change between the global North and South, with some environmental campaigners arguing that many in the South are already experiencing dangerous changes. Outside of a scattering of quotes on the subject which appeared during the Copenhagen Summit, media commentaries made little mention of this divide between North and South when discussing the two degree limit. Neither was there discussion in the media about the belief that all climate change is dangerous. The North/South division on targets was also expressed in economic forums. Whilst the G8 agreed a two degree

target, the G77 were divided between those arguing for a two degree limit and those arguing for 1.5 degrees.

9.5 Consensus

Though my findings challenge the claims of a consensus around the two degree limit, I did identify some elements of consistency in my data.

There was close agreement amongst those interviewees closely involved in the climate science and climate science-policy interface that defining a dangerous limit should be a normative act, not a scientific fact. My research shows that the idea of the two degree limit is a normative concept was not apparent in public discourses, which predominantly constructed the two degree limit as the product of a scientific and expert consensus.

Another compelling pattern in my data, at least in regards to the elite theory framework employed, was apparent in newspaper reports, namely a shared disinterest in discussing the two degree limit outside of the frames provided by elite actors. The timeline chapter of this thesis illustrated variations in media coverage of the two degree storyline. This data confirmed the elite theory used to frame my analysis. The distinct peak in reporting of the two degree limit in 2009, combined with qualitative analysis of this reporting, shows the media acting as an uncritical echo chamber for elite actor commentaries on the two degree limit. Up until 2007, the literature review and timeline shows there was no significant challenge to the belief in a quantifiable dangerous limit, with the result that the two degree limit has come to dominate the policy agenda (Anderson and Bows, 2008: 3863). Eraut and Segnit, in their examination of climate change discourse in the public sphere, state 'It is arguable that the wide media consensus on manmade climate change has removed the need for 'loud talk' – the sort of urgent, quasi-religious doom mongering that was all the more urgent and quasi-religious for its detachment from the science' (2007: 12). I understand public commentaries on the two degree limit to be a form of 'loud talk' which aims to quash dissent, and to elevate the two degree concept to the status of fact. This loud talk drowns out subaltern perspectives, and makes attempts to find other ways of understanding and responding to climate change seem irrational. Indeed, it is the bridging of so many "reasonable" sustainability discourses achieved by the two degree concept, discussed earlier in this chapter, which makes any critique of the concept seem so unreasonable and irrelevant.

Figure 3 revealed a precipitous drop off in the number of mentions of the two degree limit for the period 2010-2011. Yet between November and December 2010 the UNFCCC held a follow up conference to Copenhagen which, in the words of a press release from the UK's

Department for International Development 'marked a turning point in the negotiations to agree an international deal to tackle dangerous climate change' and agreed the two degree limit to dangerous climate change (DFID Cancun Summit on Climate Change, 13th December 2010). Yet the conference received much less coverage than the Copenhagen Summit. Nor was it attended by Western heads of state. Media interest in the issue is defined by elite interests.

There was little attention paid in news reports to the uncertainties surrounding the definition of a dangerous limit, though there is some analysis in newspapers such as the Independent and Guardian of debates around climate sensitivity. One area of uncertainty discussed in news reports was uncertainty over whether or not the two degree limit would be met. These reports, rather than revealing the uncertainties surrounding definitions of dangerous limits, actually reinforce the importance and robustness of the limit by treating with alarm any doubts that it will be met. The idea of a wide consensus on the two degree limit is communicated in media discourses by an imperviousness to the balancing norms identified elsewhere as an integral part of media discourses (Boykoff, 2007; Smith, 2005). The term 'balancing norms' refers to the idea that journalists will always try and present two sides of an argument to demonstrate their objectivity, neutrality, and fairness. It has been argued that climate sceptic voices are more prominent in the media than can be justified by the scientific evidence because these voices are effective at activating these balancing norms (Boykoff, 2008). Such balancing norms as exist are activated by disputes about climate sensitivity and what ppm level will cause two degrees of warming.

Policy-science documents and books showed some willingness to pick apart the two degree idea, but any holes identified were quickly closed over on the basis that either there was a consensus that, regardless of any remaining uncertainties, two degrees was a good limit, or that to argue for anything else was to irrational and likely to fall on deaf ears. The most telling example of this approach comes from the book entitled '2 Degrees Too High' which in its only reference to this topic actually argues for the two degree limit (Arthus-Bertrand, 2009). Environmental campaign materials used the two degree line in the same literal manner as policy documents, invoking scientific consensus as the rationale for this limit.[138]

[138] A news story appeared at the time of writing which helps explain NGO use of science to justify claims about climate impacts. A noted BBC news presenter wrote an article bemoaning what he saw as the BBC's uncritical acceptance of alarmist climate change narratives, saying 'Environmental pressure groups could be guaranteed that their press releases, usually beginning with the words "scientists say " would get on air unchallenged (Daily Mail online, 25th January 2011).

9.6 Black boxing the origins of the two degree limit

I interpret the failure of public commentaries to offer any critique of the two degree idea as evidence that black boxing the genesis of this concept is an important part of making two degree limit an anchor fit for public consumption. By the time it has reached the pages of the newspapers, via announcements from the G8, world leaders and the head of the IPCC, the concept has already made the journey from contested assumption to objective fact.

One way the black boxing works is to simply ignore the issue. The paucity of commentaries featuring analysis of the two degree limit is itself telling, and further supports my claim that the two degree limit discourse is essentially ideological. The majority of my material on two degrees has come from two sources - interviews and news reports on the Copenhagen summit. Without the Copenhagen summit my data set would have been a great deal smaller. Even the most noted climate change documentary film, 'An Inconvenient Truth' does not mention the two degree limit. Whilst I have had more success with policy-science commentaries, environmental campaign materials and some books, policy documents make very little reference to the two degree limit. Of the six recordings made of audio news broadcasts, five of which featured discussion of Copenhagen, only three made reference to the two degree limit.

Oluasson's conclusion that there exist numerous similarities between media and international policy discourse on the issue of climate change (2009: 432) is echoed in my results. I understand this as the product of a certain circularity of the same core ideas between the different discourse communities, a co-production of the knowledge. News reports featuring mention of the two degree limit do so through quotes and reports from the policy community. To some extent it is also inevitable that policy-science documents should discuss the two degree limit in the same way as policy communities, given that these policy communities draw most of their inspiration from these reports. Environmental campaign materials follow the policy line because the goal is to be heard by policy makers in order to influence policy. Books in principle should not be bounded by the need for policy relevance, and of all the public commentaries researched should be the source of the most challenging ideas. Whilst quotes from the book document family revealed a greater willingness to pick the two degree idea apart than other sources, such analysis as existed was cursory, and quickly followed by a reconfirmation of the two degree idea through reference to science and/or a more general consensus. Peterson's research into the reporting of medical issues identified similar patterns. Peterson was interested in how a particular framing of issues may shape public responses to the issues being reported and thus potentially shape public policies. He found that quotations

or citations from experts were used to lend credibility to stories by conveying the impression that information was straight from the experts' mouth and hence irrefutable. The effect of this process was that the reader was often given little reason, in the form of counter views, to doubt the scientists account (2003: 149-150). Also relevant to two degree construction examined in this thesis, their research demonstrates that reference to a highly appreciated social value may increase the receiver's tolerance for weak evidence (2003: 181). Science and environmental campaigns act as ciphers for those values for specific cultural groups, i.e. hierarchists and egalitarians respectively.

Whilst writing this chapter I was forwarded a report analysing the inception of the two degree limit (Morningstar, 2010). This report was written by an environmental campaigner, and so has not gone through a peer review process. Nonetheless, the report provides a perspective relevant to discussions of the black boxing of the two degree limit. The report in question focuses on the Villach conference of 1985 and the Stockholm Environment Institute (SEI) report of 1990, discussed in the timeline chapter. The SEI report used research from the Advisory Group on Greenhouse Gases (AGGG) to make recommendations on warming limits, proposing a low risk scenario of 1 degree of warming and a high risk scenario of two degrees. Morningstar's commentary on the SEI report interprets the decision to go for the two degree scenario as a cover-up. This cover-up is traced to the involvement of various industry think tanks and global warming sceptics in the funding of the Villach and Bellagio conferences which led to the publication of the SEI report. The funding issue is a matter of record, as is the dropping of the 1 degree target from the policy framework. In addition, Bohemer-Christiansen has argued that the AGGG was disbanded because it was criticized for being too partisan and policy prescriptive (1994). The Morningstar article aside, these perspectives were absent from my analysis of public commentaries on the two degree limit. That many key actors are aware that there is a problem with the two degree limit is made clear in my analysis. One expression of this nervousness is found in the efforts to avoid personal claims that two degrees is a dangerous limit, instead displacing ownership of the idea onto various, poorly defined epistemic communities or impersonal institutions, such as the EU, what Fowler describes as a process of 'mystification' (1991: 80). The failure of the media to discuss the topic in any form or at any time other than that defined by elite actors, as discussed above, is an important aspect of the black boxing process.

9.7 The value of targets.

It has been shown that across all data from public commentaries there is unanimity in the perceived value of a target based response to climate change. These targets define a limit to anthropogenic forcing of the climate which separates dangerous from not dangerous/less dangerous climate change. This idea of a global limit is treated with caution by most of the respondents I interviewed from the science and policy-science communities. Similar concerns were expressed by actors from these communities in conference presentations and talks. Environmental campaigners are more sympathetic to a target based regime. There were debates about whether this target should be expressed in the form of temperature or atmospheric concentrations of ppm. Where the target was expressed in terms of warming, data shows environmental campaigners differed widely on what this warming target should be. This variation was not so apparent in data from the other discourse communities.

What little examination of the issue I found in public commentaries tends to focus on discussion of atmospheric concentrations of greenhouse gases and climate sensitivity rather than the two degree limit. This divide reflects the instrumentalist world views which characterise modernity, and the promise of control offered by the quantification of the world. Atmospheric concentrations of CO_2 can be measured accurately down to parts per million - the substance can be known, changes in the amount of this gas in the atmosphere can be measured. Turning that certainty into definitive statements about consequent warming, the impacts of that warming, and which of those impacts should be described as dangerous can only be done by ignoring profound uncertainties.

9.8 Substituting dangerous limits for acceptable risk

Outside of the Copenhagen Summit, most claims about the existence of a dangerous limit were sourced from the Stern Review and the four IPCC Assessment reports. There is little or no examination in the public sphere drawing on the social sciences (economics excluded). I interpret this lacuna as a decision to avoid recognition of the value agenda expressed in the two degree limit. The presentation of the two degree target in public discourses as scientific fact, or the product of an expert consensus, in effect substitutes a discussion about what risks are acceptable with the notion of an objectively dangerous limit. Further, the target framework prioritises attention on physical impacts, ignoring the cultural dimensions of the climate. This sense of the dangerous limit as science is reinforced by the absence of the public from debates about how much warming should be considered acceptable. This is an important

issue in my research. Substituting acceptable climate change with dangerous climate change requires a focus on the words of experts and other elite actors, and an implicit acceptance of the role of global monitoring systems in achieving global targets. A discussion of acceptable changes to the climate would necessarily involve the global public, and the need to negotiate a myriad of differing opinions about what risks people want to take. Feyerebend argues, *apropos* the scientific agenda and modernity, that no way of life should implicate others who do not want to be part of that life (1978). And it is this issue which shows how climate change might be understood as the terminus of modernity's ambition to treat humanity as an undifferentiated mass. The only means by which climate change can be responded to through the global institutions of modernity is to pretend that there is a single global dangerous limit, and a single global understanding of acceptable climate change risk. My research shows that notions of plurality, often seen as a defining feature of late or post-modernity, are in fact highly constrained; the project of modernity demands universal acquiescence to particular ideas and visions of the future, such as a willingness to live with a concept of dangerous climate change which is defined in terms of elite interests.

My research shows that the two degree limit is used to constrain debate within the language of modernity - a globalised, single, quantified construction of climate change. These public accounts are at odds with the beliefs expressed by key actors in interviews, academic literature and in conference presentations. Adam, Allan and Carter argue that the media do not simply reflect the reality of environmental risk, but provide 'contingently codified (rule-bound) definitions of what should count as the reality of environmental risks' (2000: 14). My research shows that this process, in respect of the two degree limit, is more widespread than just the media. It is in fact characteristic of all public discourses.

Chapter 10

Thesis conclusion

Defining “dangerous climate change” is ultimately a value judgement to be made by societies as a whole.

Richardson et al., 2009: 12

10.1 The two degree future

The evidence presented in this thesis supports my contention that public discourses on the two degree dangerous limit are a social performance that construct climate change as a problem that can be managed through quantification. This approach displaces value positions in favour of an instrumental ontology which, in discussion of a yet to be reached dangerous limit, assumes there is time to respond to climate change within the existing pattern of social relations.

Jaeger and Jaeger, in their analysis of justifications for the two degree limit, claim that the most compelling reason for employing the idea of a two degree dangerous limit is neither scientific not economic, but psychological and social, because the two degree limit implies a collective narrative with, at its centre, a focal point that acts as a strong call to action (2010: 27). The authors describe the narrative as collective because the two degree limit is borne of a plurality of different perspectives, gleaned from ‘the relevant actors’ (2010: 25). However, in favouring elite theory over pluralist theories of political decision making, my analysis has shown that the ‘relevant actors’ are defined as those that share the values enshrined in the construction of climate change as a phenomenon with a single global dangerous limit.

By limiting the range of valid opinion, the two degree limit acts as a plot device that sustains a vision of the future which, Ross argues, has already been ‘seeded’ by the visions emanating from corporations, the state and military planners, a vision which the rest of humanity is meant to passively observe from the sidelines (1991: 131). What Ross describes as an ‘elite futurology’ is a discourse which fixes a pre-determined outcome, to which one must fit the facts (1991: 183). In respect of climate change discourses, when the facts cannot be found, subjectivity and opinion become elevated to the status of fact, and the process of elevation black boxed. My research has revealed how public discourses on climate change perform this act of black boxing.

The ostensibly progressive institutions researched in this thesis, most notably the UN (in the guise of the IPCC, the Framework Convention on Climate Change and its Scientific Expert Group Reports on Climate Change), have played a key role in ensuring this elite vision is realised, regardless of the challenges posed by climate change. IPCC scenarios, a key reference point for political and societal discussions of climate change (Girod et al., 2008) suggest a

future of incremental and manageable change through the development of the appropriate technologies. This vision of a future populated by as of yet unrealised technologies which will allow for the reproduction of modernity may tell policy makers what they want to hear, but seriously underestimates the scale of the challenge (Pielke Jr., 2007). The idea that it may not be possible to avoid dangerous climate change and sustain the practices which define modernity is absent from these scenarios. That these climate saving technologies do not exist is not seen as reason to contemplate significant political and social change, because we have not yet reached the two degree limit.

The support the dangerous limits discourse provides in constructing this vision of the future is apparent in the UN Scientific Expert report which argues that in order to avoid exceeding 2.5 degrees centigrade of warming there is a need for:

> government leadership to establish policy frameworks that create incentives for energy-system change and establish public-private partnerships for energy-technology development, deployment, and diffusion. Leaders in the private sector also need to seize opportunities to develop, commercialize, and deploy low-emitting energy technologies that will also create jobs and enable economic development. Individuals, especially in affluent societies, must also show leadership by consuming responsibly.
>
> Bierbaum et al., 2007: 3

This statement shows that industrial technology has a vital role in ensuring that the two degree dangerous limit target does not constrain profit seeking activity. This follows directly from the UNFCCC's demand that the quantification of dangerous climate change should be at a level which will 'enable economic development to proceed in a sustainable manner' (Article 2, 1992). Economists contribute to a number of the institutions charged with planning the climate future. As an example, the UK's Committee on Climate Change is an independent body established under the Climate Change Act to advise the Government on emissions targets. There are nine members of the Committee; the Chair is Lord Adair Turner, previously Director-general Confederation of British Industry (CBI). The Chief executive is David Kennedy, who holds a PhD in economics. Other staff members include Dr Samuel Fankhauser, former Deputy Chief Economist of the European Bank for Reconstruction and Development and Professor Julia King, a UK Business Ambassador. There is only one climate scientist on the committee (http://www.theccc.org.uk). Nelson argues that economists 'seek to hide highly ethically-suspect status-quo-biased value judgments under a veneer of "objective" analysis and are

guilty of assuming and seeking to ensure the future remains the same as today, rather than developing a model of how the world might be' (Nelson, 2007: 446). My research has shown how the two degree limit is described as the product of a consensus that has science at its core, not economics, and it is through the invocation of scientific expertise that the value judgements used to identify a dangerous limit are hidden. Disguising economic choices as scientific ones limits the extent of any critique, as to attack the science is to attack rationality and progress. By making capitalist values appear as scientific fact, the future scenarios signposted by the dangerous limits discourse take on a sense of inevitability (Oluasson, 2009: 252). The utility of the two degree limit in supporting elite visions of the future is enhanced by the mobility of the target. A discourse is appearing which is articulating the need to plan for a future of four or more degrees of warming. Whilst beginning to plan for such an outcome would seem a sensible precaution, such discourses also introduce the legitimacy of such a vision into the discourse, and offer the promise that such impacts can be planned for and managed. This planning is also born of the recognition that policy makers are attempting to introduce an element of flexibility into the dangerous limits target. To return to an exchange which appeared in the data analysis part of this thesis, when asked by the UK government's Environmental Audit Committee whether the government were moving the goals posts on the two degree target, the chair of the Committee on Climate Change answered:

> In a sense, the 2° had entered the debate but it was always a slightly arbitrary figure that people had taken from the past, and we did not treat it as a completely binding one. As I say, you have to remember that you cannot say, "The aim is not to go above 2°". That is just not a doable aim. You have to define the aim as, "I don't want a more than `x' per cent chance of going above 2°". Once you have accepted that there is already a certain chance of going above 2°, you are trying to work out how big a chance you are willing to accept. We ended up believing that the most vital thing is to keep the chances very, very low that we go to really high levels like 4°.
>
> Lord Turner of Echinwell, Environmental Audit Committee, February 2009

Such statements constitute the beginning of a slow trickle into the public discourse of a four degree limit which mirrors closely the gradual increase in voices backing the two degree limit, with the same type of institutions involved and driving the discussion. In common with the history of the two degree discourse, there is no evidence of any attempt to involve the public

in discussing what would appear to be a very momentous decision about humanity's future. Yet the literature on public understanding of environmental issues indicates that the dangerous limit discourse cannot fulfil its function of seeding elite visions of the future without at least some public awareness. This awareness is needed in order to achieve some buy in to what is in essence a bleak vision of the future. The dangerous limits discourse, whether that it is set at two degrees or four, by displacing the sense of threat and danger to the future, allows people to get used to a certain level of environmental degradation and social harm (Adger et al., 2009: 52). Roberts describes this displacement as a feature of the issue attention cycle, wherein people acclimatize to accept dire environmental consequences provided that these consequences are reasonably distant, both temporally and geographically (2004: 164). This helps explain why the 2003 European heat wave was not discussed in terms of the two degree limit – to do so would bring the dangers into the present, rather than 100 years hence.

10.2 Original contributions of my research

10.2.1 Constructing the two degree limit in public discourses

This is the first attempt to analyse how the idea of a two degree dangerous limit to climate change is represented in public discourse, and to identify how reliable these representations are. There is no scientific rationale for defining a single global dangerous limit. It is instead a discussion about acceptable risk, acceptable harm, to be decided under conditions of uncertainty. Making decisions about acceptable risk for all humanity might properly, in a notionally democratic, free and civilized society, be a subject for all to be involved in. However, my research demonstrates that the language used in elite constructions of the issue misrepresents the issue in such a way as to exclude the public from involvement in the decisions about the long term future. Not only is it important to show that this is happening in order to address a democratic deficit. It is also important to find alternative framings which will include public perspectives and values in the decision making process. Research has shown that failure to take public values and views into consideration when taking decisions on climate risk management issues will inevitably prove problematic. At a very basic level, climate policies will require a degree of buy-in or acceptance from those who will be affected by them if they are to be successfully implemented. Equally, with the public using internal frames against the external frames used in expert analysis of risk, the practice of risk communication becomes much more difficult (Lowe and Lorenzoni, 2005: 10). My research reveals how the two degree

limit is an exemplar of elite actors attempting to impose an external definition of risk onto the public.

10.2.2 Extent of commentaries analysed

Existing research into construction of climate change has tended to focus on newspaper reports. There is good reason for this, in so much as the media provide the primary channels by which the public come to understand abstract issues such as dangerous climate change, and is a relatively easy body of data to research, thanks largely to the LexisNexis database. However, in adopting an explicitly critical approach to my analysis of the two degree limit, I have sought to extend my analysis beyond newspaper accounts, to try and identify where challenges to the idea of a two degree limit may be found, and what form such critiques might take. By demonstrating the near unanimity in the treatment of the two degree limit across all forms of relevant discourse, including those of even the most radical environmental campaigns, I have demonstrated how these discourses help to secure a place for the two degree limit at the high table of policy making, far removed from democratic interference. This is a significant contribution to the science and society literature.

10.2.3 Merging qualitative and quantitative analysis

My methodology, in dividing two sets of discourse, public and expert, illustrates how it is possible to trace the process of elevating an ideological discourse into an objective fact over long time periods and diverse institutional and social practices. As policy increasingly takes on an international dimension, and the public become ever more distanced from the decision making process, so it becomes necessary for researchers to be able to follow and examine these developments, in order to support the democratic health of societies in the face of these changes. My research shows the potential for the erosion of democratic principles when responding to extremely complex issues such as climate change. Cross referencing data from the LexisNexis database with longitudinal analysis of commentary from a range of other outputs allows the researcher to see how interest in the two degree limit has varied in the last thirty years. By then mapping this data onto qualitative research, it is not only possible to trace the history of the debate, but also explain the patterns observed. I have shown that there was little public discussion of the two degree limit for the first thirty years of the process (there was little interest until 2007 and, as far as media accounts go, what interest was shown in 2009 has since evaporated).

10.2.4 The uses and misuses of science

My research makes a significant contribution to the science and society literature by illustrating how science is misused in support of the two degree limit. It is a commonplace to invoke a scientific consensus as the justification for defining climate change as a phenomenon with a (two degree) dangerous limit, and this is true across all public discourses researched for this thesis. Yet in my interviews with key actors, the idea that climate change has a dangerous limit of any kind was largely rejected. Instead the target discourse was seen as necessary for providing a policy architecture and for making the need to reduce carbon emissions an easy to communicate subject. Understanding the safe limit idea as an anchoring device rather than a feature of the climate system is an important issue to highlight. Given the extent and impact of dangers assumed to result from anthropogenic interference with the climate, it would be perhaps surprising for the public to know that the policy was being built on a range of concerns other than the need to prevent harm from climate change. Disentangling science from values in such a highly politicised arena is made difficult not least by confusing accounts from the scientists themselves.

10.2.5 Theoretical approaches

Whilst there have been numerous, more or less sociological, critical and constructivist discussions of environmental problems, there has been no sociological analysis of the two degree dangerous limit, critical or otherwise. Adopting a critical approach to the idea of a dangerous limit to climate change is essential to understanding the decision making process which led to this range of communities coming to a shared understanding of a novel threat. Further, by examining how a problem is constructed in a way that satisfies the needs of multiple constituencies, it is possible to highlight what aspects of the phenomenon are sacrificed in the search for a shared meaning. Understanding such compromises is the first step to clarifying whether this construction provides an accurate conception of the problem, and what other ways of framing the problem might better serve those caught up in this experiment.

10.3 What would I have done differently?

Overall, my research has been limited by the constraints of working on one's own as a PhD student. This has shaped the volume of data and the sites it has been possible to visit for interviews and field observations.

My research would ideally have benefitted from more interviews with policy actors, perhaps not those currently involved in policy making, but actors who have recently left such a role and are now free to speak more candidly. I would anticipate such insights would not likely have provided information which challenged my findings, but would rather have strengthened the robustness of the conclusions I have drawn from the data.

It would have been valuable to have had some evidence of levels of public awareness and understanding of the two degree dangerous limit, against which to judge the effectiveness of attempts to communicate the rationale for policy. I have argued that public representations of the two degree limit have masked the value laden nature of the concept in order to legitimate the target in the eyes of the public. The veracity of this theory could be better understood if there was evidence available of how the public interpreted the two degree limit concept.

An opportunity to attend the Copenhagen Summit would have possibly provided both access to a wide range of actors involved in the two degree debate and afforded insight into the negotiation process which led to the communiqué on the two degree limit. However, any advantages from attending the summit may in fact have been quite limited. A BBC radio documentary revealed a two tier negotiation process at Copenhagen. Deliberations had been characterised by an inclusive process involving all UNFCCC signatory states. Typically of attempts to reach international agreements on climate change, progress towards agreeing targets was slow and the summit looked as though it was going to end in deadlock. With the US president on his way to the summit, panic arose that the summit was going to fail. Frenetic negotiations were continuing in a number of different rooms. Just prior to Obama's arrival, the most senior negotiators from the most powerful economies were pulled out of their respective meeting rooms to meet upstairs with Barak Obama. From that brief, selective, meeting was produced the Copenhagen Communiqué, much to the anger of those excluded from this meeting (What happened at Copenhagen, BBC Radio 4, broadcast November 20th, 2010). This account reinforces the elite theory used to frame my research and indicates that, asides from access to interviewees, I would not have been any closer to the elite decision making process on the two degree limit.

10.4 Future research

A valuable contribution to policy discussions would be made by researching the extent to which the two degree limit is understood by the public as an urgent call to action which justifies the changes proposed by European governments. Such research may reveal what elements of the two degree message are accepted and which rejected, and the reasons for such reactions. Is it that there is no awareness, and that awareness would lead to behaviour change and/or acceptance of policy initiatives? If there is awareness but the message is rejected why? Is it an issue of trust?

Applying the results of this research to an analysis of the emerging four degree dangerous limit discourse would provide important insights into the decision making process on dangerous climate change limits. Whilst the elite theory approach employed in my research precludes any change in approach by policy actors on the basis of evidence showing the approach is flawed, exposing the values on which decisions about the future is being made must be the first step to a democratisation of the debate.

A continuation of the work plotting the difference between expert, private and spoken accounts of the two degree limit with public representations would be a fruitful application of Kasperson's risk amplification theories. If there is productive potential for greater public awareness of the two degree discourse then such research would help provide a clear set of procedures for ensuring the message is communicated in a way which would maximise exposure and receptivity to the message.

10.5 Policy relevance

My research provides a valuable contribution to the climate policy debate by highlighting the weaknesses of a quantitative, target based approach and arguing instead for a participatory response to climate risk. Such an approach is necessary in light of the structural failings of current approaches, which seek to address the needs of policy building. A participatory approach would instead begin from an acceptance of the uncertainties in projection future climate scenarios, and the equity issues inherent in trying to define a single global dangerous limit. Policy is locked in to existing strategies because key players have too much invested in the process of targets and treaties to allow different approaches onto the agenda (Prins and Rayner, 2007: 448). Such a structural impasse may result in the very real danger of the two degree target merely being the precursor to the introduction of a four degree target. This

thesis is an attempt to explain the need for a break from the targets approach to building climate policy.

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Sunday Telegraph

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Sunday Times

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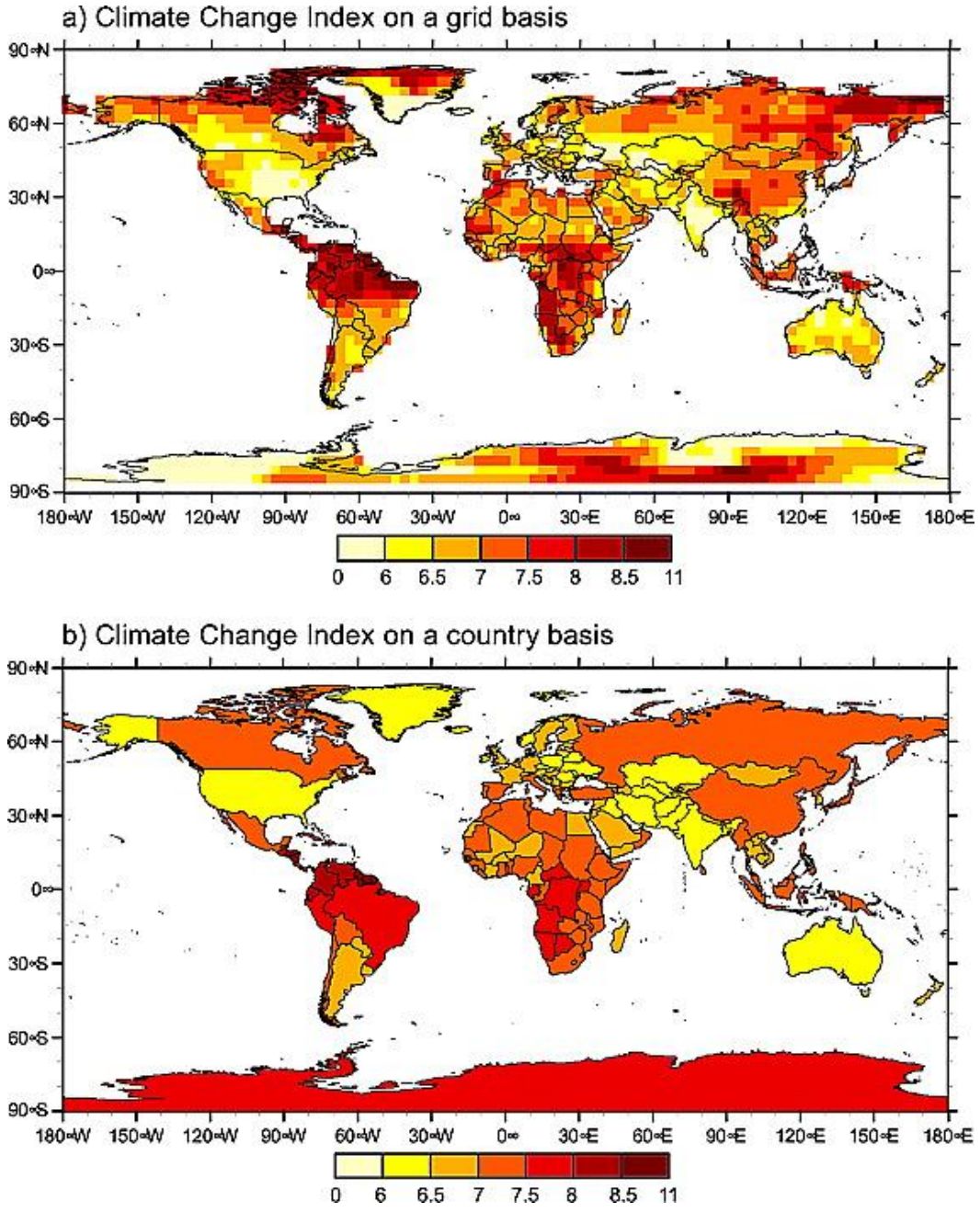
Appendix 1

Variations in warming



Taken from Baettig, Wild and Imboden (2007).

The redder the area on these maps, the greater the warming.

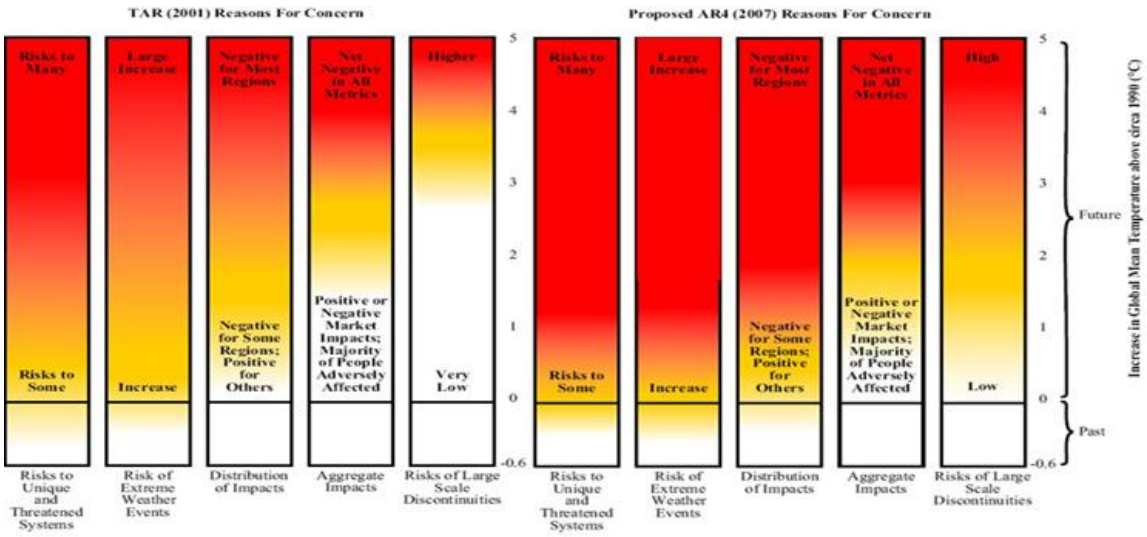
Appendix 2

Reasons for concern

This appendix shows a diagram of two versions of the burning embers diagram, one from 2001 and the other from 2007. In this diagram the red area indicates danger. These red areas begin below the two degree line in the updates version.

See Smith et al. 2009 for a full discussion of this diagram, and the reasoning behind the changes.

Taken from Smith et al. *Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) ''reasons for concern''* (2009).



Appendix 3

Table of Impacts

Table 1
Key indicators and measurement issues by area of concern

Area of concern	Benchmark impact indicators	Possible global mean temperature change thresholds[a]	Measurement issues for key indicators
Risk of large scale singularities[b]	Breakdown of the North Atlantic Thermohaline Circulation (THC); disintegration of the West Antarctica Ice Sheet (WAIS)	3°C–4°C	Probability distributions for such events are unknown; lack of knowledge about the type and rate of change. Limited evaluation of the range of potential .damage costs associated with catastrophic events, due to lack of data (possibly infinite) uncertainty, disagreement about key assumptions for evaluation
Aggregate impacts[c]	Aggregate monetary or economic welfare losses (e.g. change in GDP); changes in numbers of people affected (e.g. flooded)	2°C–3°C	Lack of comprehensive coverage and of agreement on valuation approaches for non-market losses; discounting techniques over long time frames for different types of costs; valuation of human life; failure to consider sector inter-relationships, e.g., between water and agriculture impacts. On numbers of people affected—number of studies is limited
Distribution of impacts[d]	Monetary or economic welfare losses by region; changes in numbers of people affected by region	2°C–3°C	Regional downscaling of global climate models; lack of consistent or clear climate signals at the regional scale; socio-economic and vulnerability baseline scenarios or choice of base year for comparison. Lack of agreement on how to represent and measure regional impacts
Risks of extreme weather events[e]	Frequency, intensity of tropical storms and precipitation events, drought; increase in maximum T and number of hot days, increase in minimum T and decrease in number of cold/frost days	1°C–2°C	Attribution to climate change, climate variability (natural variations around a mean) versus climate change (changes in the mean and distribution about the mean); socio-economic change and vulnerability, autonomous adaptation and cost of planned adaptation. Lack of consensus on definition of extreme events and lack of homogenous data (e.g. on costing approaches, baselines). Valuation of human life and health effects remains controversial with limited empirical data from developing countries. Selection of base scenario and/or years for points of comparison
Risks to unique and threatened systems[f]	Coral reefs, mangrove forests, mountain glaciers. For species key indicators are: population abundance, species distribution, morphology, behaviour, community structure and species survival; for glaciers: pace and magnitude of glacial retreat	1°C–2°C	How to measure the state of these systems over time? Thresholds for irreversible change; sensitivity to rate versus absolute T changes, precipitation or sea level changes? Varying views on the magnitude of losses and on the socio-economic value of such losses; lack of data required for valuation in different regional contexts

Sources: Authors, building on Smith et al. (2001), IPCC (2001a, b) and other sources noted below.
[a] See also Section 3.2 on corresponding concentration levels.
[b] Stocker and Schmittner (1997), Schneider et al. (2000), Narain and Fisher (2000), O'Neill and Oppenheimer (2002), Vellinga and Wood (2002), Tol (2003), Rahmstorf (2002, 1996), Alley et al. (2003), Baranzini and Chesney (2003).
[c] For surveys of work in this area see Tol (2002) and Pearce (2003). On numbers of people affected see Parry et al. (2001) and Arnell et al. (2002).
[d] Tol (2002), Arnell et al. (2002) and Parry et al. (2001).
[e] Easterling et al. (2000), Cubasch and Meehl (2001) and Milly et al. (2002).
[f] Root et al. (2003), Parmesan and Yohe (2003), Etterson and Shaw (2001), O'Neill and Oppenheimer (2002), and Leemans and Eikhout (2003). On the importance of preferences in valuation see Yohe (2003), Roughgarden and Schneider (1999) and Azar (1998).

(Taken from Corfee-Merlot, J. and Höhne, N., 2003).

Appendix 4

Data sources

News stories

Table 21 lists the publications in descending order of the number of relevant two degree stories identified. The results are slightly skewed by the fact that in some instances the lexis-Nexis database groups the weekly and Sunday editions of a newspaper. For the purposes of sampling I went through the stories in a chronological order, taking every 3rd relevant item, giving a total of 100 articles for analysis.

Table 21: Breakdown of Lexis-Nexis and BBC Online news database search for "two degrees" and "2 degrees".

Source	**Number of articles (no date range applied in search)**	**Number of articles beginning 30th October 2000**	**Number of relevant articles beginning 30th October 2000**	**Beginning of date range available in the Lexis-Nexis database**
The Guardian	351	178	57	14th July 1994
The Independent	202	115	39	19th September 1998
Daily Telegraph	106	107	39	30th October 2000
Daily Mail and Mail on Sunday	220	141	36	1st January 1992
The Times	279	147	35	1st July 1985
The Observer	98	66	32	7th October 1992
BBC News online	120	120	18	n/a -
Daily Express and Sunday Express	84	84	14	2nd October 1999
Independent on Sunday	63	31	11	19th September 1998
The Sun	67	66	6	1st January 2000
The Sunday	84	31	6	1st July 1985

Times				
Daily Mirror and Sunday Mirror	125	96	5	29th May 1995
Sunday Telegraph	27	27	3	30th October 2000
Total	**1749**	**1101/1209 recount**	**301**	

Table 22: Events attended which yielded data relevant to discussion of the two degree limit.

Event	Speaker	Date	Notes
Climate Camp, Heathrow	George Monbiot	June 2007	Talk discussing two degree limit.
Climate Camp, Heathrow	Zero Carbon Britain	June 2007	Panel discussion on technological means of staying under two degrees.
Dangerous rates of change conference, Exeter University	Professor Sir Brian Hoskins, Committee on Climate Change	September 2008	Opening presentation for conference.
Dangerous rates of change conference, Exeter University	Professor Kevin Anderson	September 2008	Presentation on emissions for avoiding dangerous climate change.
Dangerous rates of change conference, Exeter University	Professor Herman Held	September 2008	Economic feasibility of the two degree target.
4 degrees and beyond conference, Oxford University	Prof Diana Liverman, Mark Lynas (journalist and author), Professor Kevin Anderson (Tyndall Centre), Dr Chris West(UK Climate Impacts Programme), Ian Noble (World Bank Climate	September 2009	Panel discussion on the implications of planning for four degrees of warming.

	Change advisor) and James Painter (BBC world service)		
4 degrees and beyond conference, Oxford University	Professor John Schellnhuber	September 2009	Opening keynote speech.
British Sociological Association – Putting Society into Climate Change	Malcom Wick, ex Government Minister for Energy	February 2010	Opening Keynote Speech.

Appendix 5

Roles and responsibilities of organizations and institutions cited in this thesis

This information is taken primarily from the websites of the respective organizations.
This information is merely descriptive, and is not intended as an analysis of the organizations, their inter-connectedness and the validity of their work. However, as an historical note, it is perhaps worth noting that many of these organizations arose in the early 1970's in response to a combination of economic and environmental problems.

1. UN organisations[139]

UNEP – The United Nations Environment Programme was founded in 1972. UNEP co-ordinates coordinates United Nations environmental activities, broadly defined. It has a particular focus on helping developing countries implement environmental policies. *www.unep.org*

Intergovernmental panel on Climate Change – The IPCC was formed in 1998 and is, in its own words 'the leading international body for the assessment of climate change'. The IPCC was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. The IPCC is a scientific body which reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.
http://www.ipcc.ch/organization/organization.shtml

UNFCCC – The convention is an agreement which 'sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change'. The Convention entered into force on 21 March 1994. Under the Convention, governments:

[139] I do not provide details of the UN itself as most of its climate change interventions occur through the subsidiary bodies listed here.

- gather and share information on greenhouse gas emissions, national policies and best practices
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- cooperate in preparing for adaptation to the impacts of climate change

There are 194 signatories to the convention. A full list is available at *http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php*

2. Economic organizations[140]

G8 – The G8 has no headquarters, budget or permanent staff. The G8 is made up of the world's 7 largest economies, and Russia. The other 7 countries are

- US
- Canada
- Germany
- Italy
- France
- UK
- Japan

The G8 was born out of the economic problems of the early 1970's. G8 members can agree on policies and can set objectives, but compliance with these is voluntary. [141] The G8 meets annually.

G20 – The G20 is a larger version of the G8 forum. The G20 was established in 1999 and, like the G8 was formed in response to a series of economic problems, most notably those arising in Asia in 1997 in the wake of the 1997 financial crisis. Its goal was to 'stabilize the global financial

[140] Space does not allow me to try and provide a history of the EU. See Shaw (2010) for discussion of EU environmental policy and climate change.

[141] Taken from *'Profile: G8'.* BBC News online 26th June, 2010. http://news.bbc.co.uk/1/hi/world/americas/country_profiles/3777557.stm <Accessed 2nd November 2010>.

markets' (www.G20.org homepage). The G20 is made up of 19 individual countries and the EU. See *www.G20.org* for a list of member nations. As with the G8, the G20 meets annually.

G77 - The Group of 77 is the largest intergovernmental organization of developing states in the United Nations, which provides the means for the countries of the South to articulate and promote their collective economic interests and enhance their joint negotiating capacity on all major international economic issues within the United Nations system, and promote South-South cooperation for development. The Group of 77 (G-77) was established on 15 June 1964 by seventy-seven developing countries. See *http://www.g77.org/doc/* (from where this information was taken) for a list of G77 nations.

Major Economies Forum - The Major Economies Forum on Energy and Climate (MEF) was launched on March 28, 2009. The MEF is intended to facilitate a candid dialogue among major developed and developing economies, help generate the political leadership necessary to achieve a successful outcome at the December UN climate change conference in Copenhagen, and advance the exploration of concrete initiatives and joint ventures that increase the supply of clean energy while cutting greenhouse gas emissions.
The 17 major economies participating in the MEF are: Australia, Brazil, Canada, China, the European Union, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Russia, South Africa, the United Kingdom, and the United States. *http://www.majoreconomiesforum.org/about.html*

New Economics Foundation (NEF) – NEF is a left of centre think tank which 'aims to improve quality of life by promoting innovative solutions that challenge mainstream thinking on economic, environment and social issues. NEF was founded in 1986. *http://www.neweconomics.org/about*

3. <u>Scientific organizations</u>

Met Office/Hadley Centre – The Met Office describes itself as **'**the UK's National Weather Service. We have a long history of weather forecasting and have been working in the area of climate change for more than two decades. We are a Trading Fund within the Ministry of Defence, operating on a commercial basis under set targets'. *http://www.metoffice.gov.uk/about-us/who*
The Met Office is part of the World Meteorological Organization. The Met Office includes the Hadley Centre, which carries out climate change research for the Met Office. The Hadley

centre was opened in 1990, and is largely co-funded by Defra (the Department for Environment, Food and Rural Affairs), the Ministry of Defence and Department of Energy and Climate Change (DECC). *http://www.metoffice.gov.uk/climatechange/science/hadleycentre/*

World Climate Research Programme (WCRP). The WCRP was established in 1980 under the joint sponsorship of the International Council for Science (ICSU) and the World Meteorological Organization (WMO) , and, since 1993, has also been sponsored by the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

The main objectives are to determine the predictability of climate and to determine the effect of human activities on climate. Whilst WCRP organizes meetings, workshops and conferences to coordinate and facilitate climate research the research itself is done by individual scientists working in national and regional institutes, laboratories and universities. *http://www.wcrp-climate.org/history.shtml*

Royal Society - The Royal Society is the oldest scientific academy in continuous existence..The Society has three roles: it is the UK academy of science promoting the natural and applied sciences, a learned society, and a funding agency. http://royalsociety.org/

University of East Anglia, Climatic Research Unit - The aim of the Climatic Research Unit is to improve scientific understanding in three areas:

- past climate history and its impact on humanity;
- the course and causes of climate change during the present century;
- prospects for the future.

The Climatic Research Unit (CRU) was established in the School of Environmental Sciences (ENV) at the University of East Anglia (UEA) in Norwich in 1972. *http://www.cru.uea.ac.uk/cru/about/*

4. <u>Policy/science</u>

Tyndall Centre – The Tyndall Centre Is an inter-disciplinary organisation which brings together researchers from a range of backgrounds together with business leaders, policy advisors, the media and the public in general to develop sustainable responses to climate change. http://www.tyndall.ac.uk/about

Committee on Climate Change - The Committee on Climate Change (CCC) is an independent body established under the Climate Change Act to advise the Government on emissions targets, and to report to Parliament on progress made in reducing greenhouse gas emissions. The Committee has as its main roles to

- Provide independent advice to Government on setting and meeting carbon budgets and targets.
- Monitor progress in reducing emissions and achieving carbon budgets.
- Conduct independent research and analysis into climate change.
- Engage with representatives interested in climate change from across the UK in order to share research and information on climate change and gain input into our analysis.

http://www.theccc.org.uk/about-the-ccc

The Grantham Research Institute – The Grantham Research Institute is home to climate change and environment research at the London School of Economics and Political Science (LSE). The Institute is chaired by Lord Nicholas Stern, and brings together international expertise on economics, finance, geography, international development and political economy to establish a world-leading centre for policy-relevant research and training in climate change and the environment. http://www2.lse.ac.uk/GranthamInstitute/About/home.aspx

The International Energy Agency (IEA) – The IEA is an intergovernmental organisation which acts as energy policy advisor to 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. Founded during the oil crisis of 1973-74, the IEA's initial role was to co-ordinate measures in times of oil supply emergencies. As energy markets have changed, so has the IEA. Its mandate has broadened to incorporate the "Three E's" of balanced energy policy making: energy security, economic development and environmental protection. Current work focuses on climate change policies, market reform, energy technology collaboration and outreach to the rest of the world, especially major consumers and producers of energy like China, India, Russia and the OPEC countries. http://www.iea.org/about/index.asp

The Carbon Trust – The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. The Carbon Trust provides specialist support to

help business and the public sector cut carbon emissions, save energy and commercialise low carbon technologies. http://www.carbontrust.co.uk/about-carbon-trust/who-we-are/pages/default.aspx

The Department for Environment, Food and Rural Affairs (Defra) - Defra is a Government Department in the UK. Defra was formed in June 2001 when the Ministry of Agriculture, Fisheries and Food (MAFF) was merged with part of the Department of Environment, Transport and the Regions (DETR) and with a small part of the Home Office. In October 2008, the climate team at Defra was merged with the energy team from the Department for Business Enterprise and Regulatory Reform (BERR) to create the Department of Energy and Climate Change (**DECC**). The formation of DECC brought together energy policy and climate change mitigation policy (previously with Defra).

These changes reflect recognition that climate change and energy policies are inextricably linked – two thirds of our emissions come from the energy we use. Decisions in one field cannot be made without considering the impacts in the other'.
http://www.decc.gov.uk/en/content/cms/about/about.aspx